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CONTENTS

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The Bulletin has been compiled and edited by Sylvia P Beamon, MA, (2 Morton Street, Royston, Hertfordshire. SG8 7AZ) with assistance from Martin C Black, Maureen Mahony, Bernard O'Connor and Malcolm Tadd

EDITORIAL

I was surprised to have received several comments on my topic of Histoplasmosis in Bulletin No.26. including hearing from one member who had the disease in 1980. I thought members might be interested in another form of infection, even if rare. Please write in if anyone has had a similar problem.

CAVE FEVER

An archaeologist in London, Shimon Gibson, in response to a letter of mine in 1988, reported that he had experienced 'cave fever' during the final stages of the excavation of a Byzantine Monastery at the site of Ras et-Tawil in northern Jerusalem (Israel) in 1981. The symptoms included: a weak-ness of the limbs, hallucinations, a great thirst, head pains and high fever. He was hospitalised for two weeks. At first the doctors at Hadassah Hospital, Jerusalem, were not really sure what the problem was and suggested it was some form of unknown virus. At a later stage a specialist diag-nosed it as 'cave fever' (akin to the Rocky Mountain fever in the U.S.A.). The last known case being reported some 100 years ago. It can only be 'caught' from caves which have been used by shepherds as shelters for herding sheep and goats overnight. Some form of parasite associated with a tic, which feeds off the droppings of these animals, can infect the blood stream if it comes into contact with the hands or feet of a human being. These 'bugs' live in crevices in the floors and walls of a cave. He was probably infected while measuring the grotto of the Byzantine Monastery, which entailed him touching his hands against the walls and floor, which was a rock-cut cave that had been open for many years with about 50 cms. accumulation of animal dung on its floor.

It took Shimon about two months to recover from the 'cave fever' and for a while he could only walk round with the use of a stick. Since 1981 he has surveyed and excavated numerous caves and rock-cut tombs without any problem what-soever. To prevent anybody from getting 'cave fever', he always insists that his volunteers or workmen wear high boots, long trousers, shirts with long sleeves, gloves and hats while digging within a cave. Unfortunately, very few archaeologists working in Israel know anything about 'cave fever' and frequently they can be seen working in a cave with sandals, shorts, T-shirts and without gloves or hats! In his opinion, and I agree with him, these archaeologists are clearly at risk!

Apparently, the Arabs take precautions before they use caves for habitation. They light fires within, all the way round the walls for as long as a week until the walls are blackened, then plaster the walls with whitewash of quick-lime. Archaeologically speaking, cave walls heavily blackened with a soot deposit could be interpreted as structures being used over a very long period of time rather than being deliberately blackened for health purposes - so archaeologists beware.

Sylvia P. Beamon.

STOP PRESS

5 – 7 July 1991. – ***International Congress on Souterrains*** organised by the *Societe Française d'Etude des Souterrains* is being held at Chateau de Weinberg (Kefermarkt) Oberosterreich, Austria. A visit to the site of Hallstatt is arranged for the 4th. July (day before the Congress).

10 – 14 July 1991. – ***Third International Symposium on Underground Quarries,*** in Naples, Italy, organised by *Societa Speleologica Italiana; Club Alpino Italiano; Giunta Regionale della Campania; Consiglio Regionale della Campania; Commune di Napoli.*

Details of both events from Malcolm and Barbara Tadd, 65, Trindles Road, South Nutfield, Redhill, Surrey.

Diary Date: **7 – 11 August 1992,** ***International Symposium 1992*** will be held in the Bristol/Bath (England) area and 60 places have been booked at the Bath College of Higher Education, Newton Park, near Bath.

SNOW STORAGE IN 'ARTIFICIAL GLACIERS' - THE ICE-PITS OF MONTEFORTE, ITALY

Nicoletta Santangelo and Antonio Santo

ABSTRACT

An interesting sketch of mountain industrial archaeology of an economy which no longer exists.

Somebody crossing the Campo Maggiore might well ask themselves what the strange holes are that are found in this area usually at the bottom of the slopes. Perhaps, like us, they would never have thought that they hide a local tradition now lost in time. The answer came to us almost by accident from Dr. Alfonso Piciocchi who invited us to research information into the so-called "Ice Holes", genuine ice depots, which provided a commercial income to Monteforte Irpino and the neighbouring villages. These dwellings were situated on the W side of the Partenio mountains in the valley between Naples and Avellino (hence the village's name), and here we heard the story of the ice holes from the old people of the area and in particular Carmine Murano.

In the Vetriera area, about 700m above sea-level, during the last century and into the early 1900s, according to what we were told there were dozens of these ice holes. That is, huge artificial holes, more or less circular with a diameter of 6m and a depth of 8m dug out of the pyroclastic rock which covers these mountains. Each of these holes was lined with tufa bricks and covered with a small construction [lid/head gear?]. They were intended to conserve ice until the summer thus allowing the owners to sell it in the neighbouring towns.

With the first snowfalls the work of the ice holes began. Men and women were recruited from the neighbouring villages called by the sound of a "tufara". The womens' work was to collect the snow in large baskets and to carry it on their heads to the ice holes where the men helped them tip out the contents. Inside the holes other men and children, generally four of them, worked to spread out the snow and consolidate it. The ice hole was in fact divided into two parts; in one the snow was levelled, and in the other - often to the rhythm of a drum, sometimes accompanied by a pipe - the snow which had previously been spread out was stamped down. These operations were repeatedly and alternately performed until the hole was filled.

A "foreman" directed the work and encouraged the workers with a whip repeating the directions "n'faccia a' fossa" (which means stamp down the snow at the edge of the pit). Dried leaves were placed round the edges to stop the ice from melting and they were also used to cover the ice hole once it had been filled. Some of these holes could hold as much as 150 cubic metres of snow.

The ice sales began with the arrival of the warm weather. On orders [commissions], it was transported to the various villages especially Nolano and, it is said, even as far as Naples. The ice was excavated by first cutting it into large blocks with axes and then lifting it to the surface with a system of ropes and pulleys [tackle]. Finally, in the early morning, it was taken to the villages on carts.

Obviously the profit depended on the snow fall, which of course was not certain. In connection with this there is a story about Santo Beluscio who came from Mugnano del Cardinale and owned many holes at Monteforte. In a year when the snow was very late (it was already March), seeing his earnings in danger he went to Montevirgine "with his gun and his dog" to pray to the Madonna. It is said that a picture of the event was preserved until recently at the sanctuary and it appears that his request was granted with a very heavy snowfall the next day.

With the coming of the ice factories this commerce gradually grew less important and the villages' economies suffered a crisis. At this time the ice holes were abandoned and with the passing of years were turned into storage rooms, earthed up or covered with housing [built upon]. Today it is difficult to find a complete ice hole although some have been preserved in the Campo Maggiore area. These are the so called "stumps", which are smaller and shallower ice holes.

During our short stay at Monteforte the old people were very disappointed not to be able to show us an ice hole and if photos exist it was not possible to obtain them. But with their memories they were able to reconstruct them in our imagination. For this we particularily thank Carmine Marano, perhaps the last ice hole "foreman".

We also hope that this brief note will lead to the collection of further information on this old tradition. It would seem that the ice industry was widespread in many of the Southern appenine villages, a fact which is confirmed by the toponymy of the area.

Extract from L'Appennino Meridionale - Journal of the Naples Section of the Italian Alpine Club. 1988.

Speleological Group of the Italian Alpine Club, Naples.
With thanks to June Farrel who translated the article from the Italian.

Veil lifts on home of V-2s

From REUTER
IN PEENEMÜNDE

IN THE first postwar tour by a Western news organisation of Peenemünde, the Baltic island village where scientists like Werner von Braun developed the deadly V-2 flying bomb, Captain Bernd Fischer of the East German Navy and Major Joachim Saathoff of the air force showed the gigantic scale of the base. Set up in 1936, it was reduced to rubble by Soviet forces at the end of the war. Now it is a skeleton of tangled steel and shattered concrete.

The visit ranged over the shell of a liquid-oxygen plant for rocket fuel, the rusted rail network that transported the ballistic weapons, underground tunnels and bunkers, and the overgrown but indestructible pillars of an enormous missile factory.

In a barely accessible forest clearing the officers pointed to the remains of Test-Pad No 7, a large, water-filled basin enclosed by stumps of reinforced concrete. "This is where space history began on October 3, 1942, when the first V-2 rocket made a perfect flight 120 miles downrange into the Baltic," Captain Fischer said.

In a history of the base, Walter Dornberger, the Peenemünde director-general who later worked at the heart of the space programme, described the V-2's power as a weapon. "For the first time a machine built by man hit the Earth with a force equivalent to that of 50 hundred-tonne express locomotives travelling at 60 miles per hour," he said.

Elderly residents of the remote village close to the Polish border remember the roar of the rockets and the strange "frozen lightning" they began to see high in the sky as the tests multiplied. They recall, too, a night in August 1943 when British bombers pounded the site, killing 2,200 people, and a big US Air Force raid a year later.

In the end, Peenemünde was overrun and its physicists captured by the Allies, leading to a postwar superpower joke that the space race would depend on whether *their* German rocket scientists were better than *our* German rocket scientists.

Permission has been granted by *Reuter* in London for the reproduction of the article which appeared in *The Times* 16:6:1990. *Sub.Brit.*No. 26 carried articles on the V1, V2 and V3 flying bombs and their bunkers.

The accompanying photograph is of a V1 *doodle bug* flying bomb recently acquired and sited at the Imperial War Museum, Duxford, Cambridgeshire – Photo Sylvia P Beamon, 1990.

SUBTERRANEAN STRUCTURES ON HIRTA, ST. KILDA, SCOTLAND.

Sallie Basham

Introduction

Hirta is the largest of the St. Kilda group of outer Hebridean islands; it has an area of nearly 1600 acres and lies more than 100 miles west of the Scottish mainland. In 1930 the last inhabitants of Hirta were evacuated and the island is now occupied by the National Trust for Scotland. It has been argued [2] that Hirta has been occupied for nearly 4000 years, but dating is difficult because Hirta is poor in natural resources: there is no naturally occuring metal or flint, no clay source has yet been found and there is no known indigenous pottery. Trade with such a remote island would always have been difficult, and materials and trade items scarce and precious.

> The most widespread and note-worthy features of the tree-less Hirta landscape are cleitean (photograph 1), dry-stone structures used for storing turf, manure or crops, and for drying birds and fish. Seton [3] describes cleitean as 'dome-shaped stone buildings, resembling ovens,..., eight or ten feet in diameter, and from four to five feet in height, with a small doorway capable of admitting an ordinary person on all-fours. Their form is round when they occupy a level position on the summit of a hill, and oval when placed on a hill-side. They are ingeniously constructed by gradually diminishing the courses of dry stone; affording a free current to the air at the sides, the top being closed by heavy stones, and protected from the wet by a covering of turf.' Harman has worked for several years surveying cleitean and descriptions and plans are given in [4].

Structures on the South Side of Hirta

In recent centuries, the main residential area on Hirta has been a sheltered bay on the S side of the island. The earliest subterranean structure is a souterrain. It lies within the main village area behind the single row of 19th century houses which face the sea. It has a flagged floor, stone walls and a roof of large flat stones. It is about 4 feet [1.2m] high and 25 feet [7.50m] long with a short side passage. At the present entrance (photograph 2) there may have been two side passages with the main section continuing for a further 10 feet [3m] over which no roof slabs remain. 'It was thought to have been a house or hide-out, but recent theories suggest an ice house for the storage of food'[2].

The Reverend Neil Mackenzie [1] was responsible for inspiring the St. Kildans to undertake substantial rebuilding in the 1830s, during the course of which several stone cists were found. Most contained pottery (none of which survives) and some contained bones. Two large stone slabs in the glebe are the only remaining evidence for the cists near the church which Mackenzie describes. Stell and Harman [4] opine that these underground burials may have been of Bronze Age date and describe one remaining underground cell. It is situated between the village street and the bay, and is oval, stone lined, about 4 feet [1.2m] long and covered with removable stone slabs (photograph 3).

Early houses on Hirta were semi-subterranean and similar in structure to cleitean; when later dwellings were built some of the older ones were adapted for storage. The best known extant example of an early domed house is Calum Mor's House, 'a windowless building of large corbelled blocks forming a continuous wall and roof' [4], which seems to have had adjacent stone cells. From the outside, the house has the appearance of a stony, grass-covered hillock. According to Quine [2], Calum Mor's House may date back to around 600 AD; however, others suggest 17th century and the Sites and Monuments Record states 'seventeenth century or earlier'.

Later houses are thought to have been higher and thatched with turf, they had adjacent bee-hive shaped cells with low connecting tunnels. Gradually the structures were developed and rebuilt and in the early 19th century the St. Kildans lived in 'black houses' similar to those elsewhere in the Hebrided. Domestic structures and their development are described in [2] and [4].

Structures on the North Side of Hirta

In a shallow, fertile valley on the N side of Hirta there are several dry stone structures which may at one time have been permanent dwellings, although in the historical period they were used as summer shielings [a shepherd's summer hut]. There are also at least two semi-underground storage places. These are in sheltered positions under very large rocks and have been further protected from the weather by dry stone walling and contain turves stacked on lines of stones. These were discovered by Emery of Durham University and there are no known literature references to them. The turves appear to have remained undisturbed since the St. Kildans left Hirta and, obviously, these structures would repay further investigation.

References

1. Mackenzie, J.B. (1911) Episode in the Life of Rev Neil Mackenzie at St Kilda from 1829 to 1843.
2. Quine, D.A. (1983) St Kilda Revisited Dowland Press
3. Seton, G. (1878) St Kilda William Blackwood & Sons
4. Stell, G.P. & Harman, M. (1988) Buildings of St Kilda

The Royal Commission on the Ancient and Historical Monuments of Scotland.

Fig 1: Souterrain entrance,
Hirta, St. Kilda,
Scotland - photo
K. Verling, 1988

Fig 2: Cleatean, Hirta - photo
K. Verling, 1988

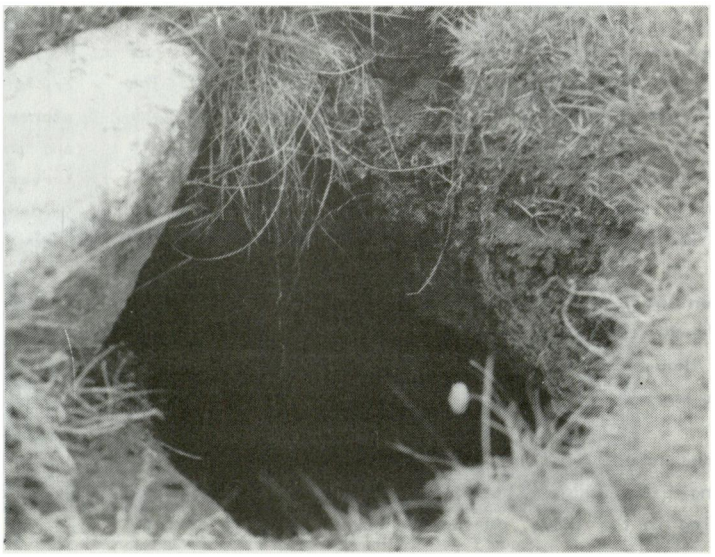
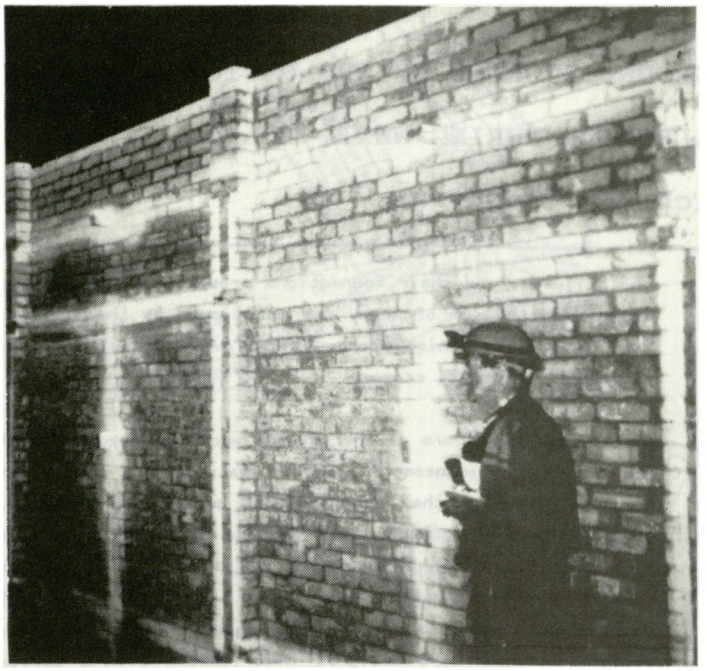


Fig 3: Underground cell,
possibly of Bronze age
photo - S. Basham, 1990



MANOD SLATE MINE, NORTH WALES

Fig 1: Manod Slate mine - showing the dividing walls within the caverns constructed to store pictures from the National Gallery in WWII. Michael Jack in the foreground

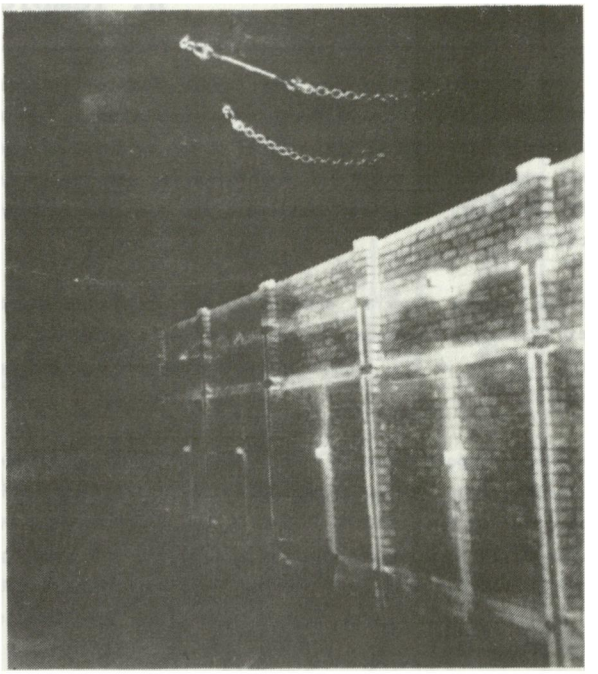


Fig 2: Chains still remaining in the roof to support open mesh fabric. This was to prevent the risk of small pieces of slate falling and causing damage to the stored pictures

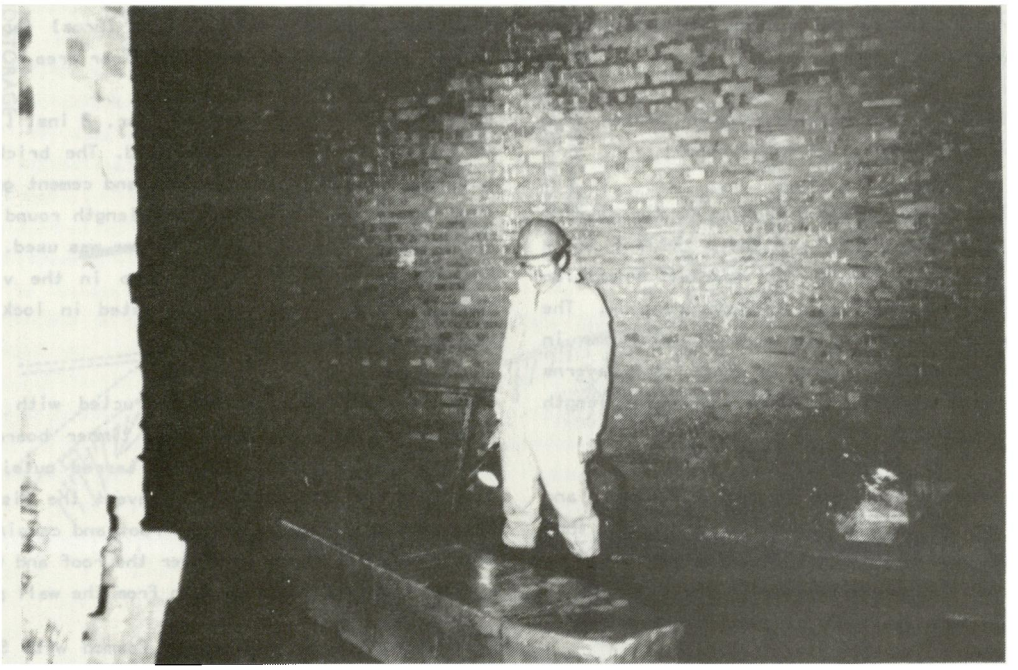


Fig 3: Sub. Brit. member inspecting a lead coffin 'prop', left behind by a TV camera crew

Photos taken by S. P. Beamon, 1988

MANOD (N. WALES) - UNDERGROUND STORAGE OF THE NATIONAL GALLERY ART COLLECTION DURING WWII

H. Temple-Richards (reprint)

In the second year of the War [1940] Temple-Richards, on behalf of H.M. Office of Works, was requested to advise on the possibility and suitability of using certain underground slate workings in the Welsh mountains for conversion into a safe storage for the National Gallery collection of pictures.

Six very large caverns, created by workings, lay about 750 feet [228.60m] in from the face and were approached by a small heading 6 ft. [1.82m] square from an outside raised plateau.

The cavern roofs were of slate formation of considerable thickness with igneous rock overlying them, and having a rock cover of over 200 ft. [70m] to the outer surface of the mountain. Having regard to the difficulty of finding any other suitable site, the Author advised that this site could be utilised safely and economically from an engineering point of view.

Considerable seepage existed in all the caverns, with consequent saturation of the air. About 3 miles [4.86km] of mountain road and track had to be surfaced and the road lowered under a railway bridge below the bridge abutment footings. At the top end (in the mountains) it was necessary to construct a new 12 ft. [3.65m] road on the side of the mountain, leading up to the raised plateau and entrance to the underground caverns.

All this work had to be done generally under winter snow conditions and with serious shortage of transport.

The 750 ft. [228m] of tunnel heading leading to the caverns was opened up to pass 5-ton lorries, and a jubilee track railway was laid in the centre of the fairway. Precision line and grade ensured absolutely smooth running. The opening of the heading produced no abnormal problems in tunnelling, all the excavation being in slate. The caverns were extensive, in some cases up to 400ft. [122m] in length and 60 ft. [18m] in width.

Half of one large cavern roof was considered unsafe, and consequently none of the buildings were placed under that portion of the roof, and the nearest building was sited so that a fall would not be likely to involve the building in it. Extra precaution was taken to strengthen the end-wall adjacent to that site.

The remaining cavern roofs were gone over carefully, and any loose bedding was removed. In certain places in the roofs, it was deemed necessary to drill about 8 ft. [2.50m] up and fix iron clamps. Instructions were issued for the roofs to be inspected closely at short intervals. Temporary scaffolding of tubular steel was erected for the purpose when required.

The buildings and their foundations presented a problem, in that a limited sum of money was sanctioned by the Treasury for these works, which consequently involved designing the planning with strict economy.

Several of the floors of the caverns were composed of about 20 ft. [6m] thickness of dumped slate debris from past workings; some of the dumps were of quite recent origin. Extensive spread footings could not be afforded, nor would time permit such a procedure. The buildings that had to be founded on the slate bedding were not heavy structures, but they had to be absolutely dry, and naturally free from any settlement. They were designed in brickwork with a cavity and inner lining and concrete floor, with a bituminous membrane.

The method of foundation was as follows:-
The dump surface over the whole floor area and about a yard [1m] width beyond, was picked and scraped to a fairly smooth and level surface.

Trenches 12 inches [30cms] deep and the width of the wall foundations were dug. Uneven places in the floor area were then evened up with 6 : 3 : 1 concrete brought to a minimum thickness of 2 ins. all over the floor area, the wall foundation trenches being concreted at the same time. A bituminous sheeting with 2 ins. [5cms] lapped and sealed joints were laid over the whole floor area.

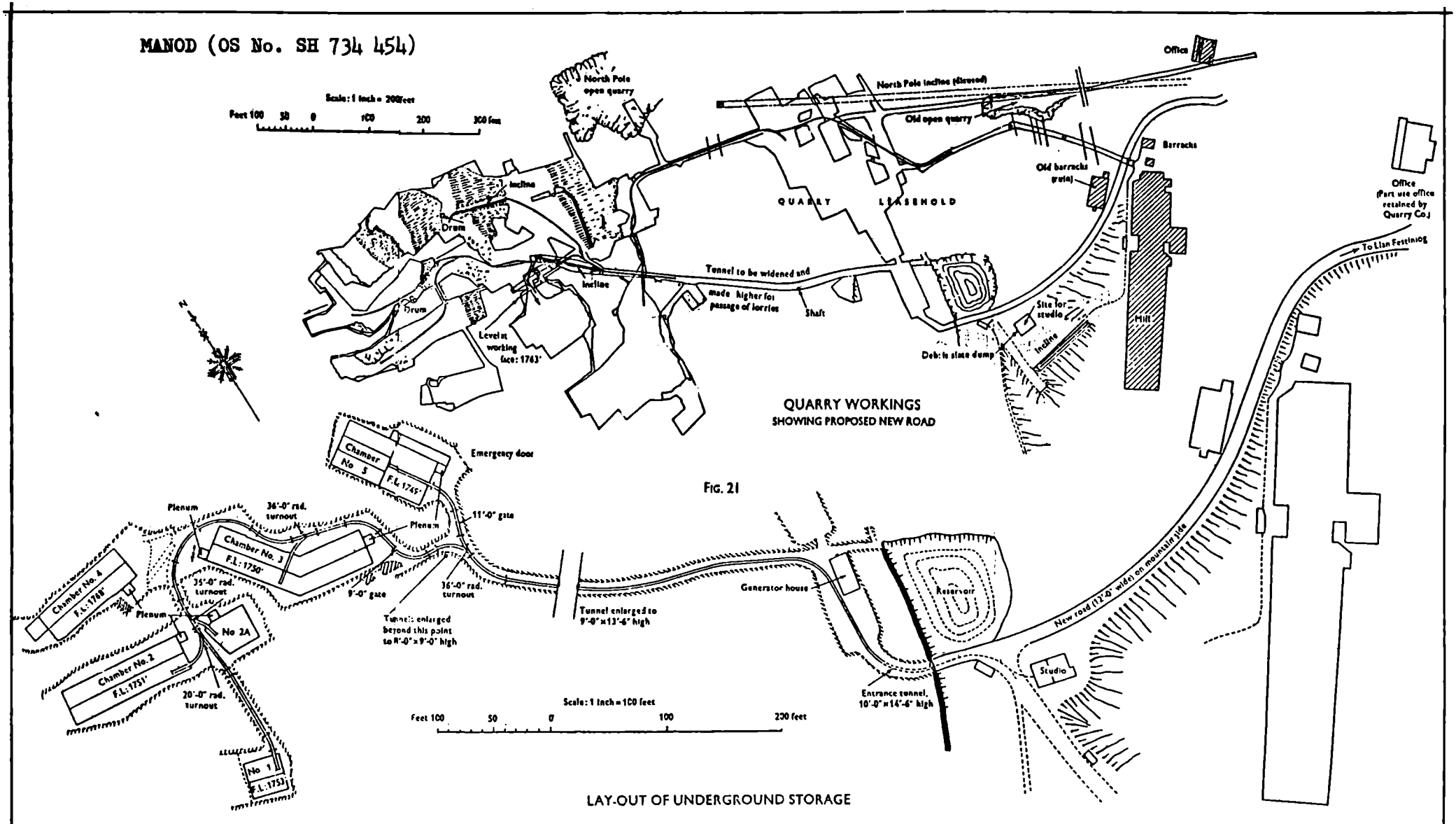
Following that, the concrete floor, 3 ins. [7cms] thick and of 6 : 3 : 1 mixture, was laid. The brick walls of the building were then put in hand, and cement grout was poured from water-cans, throughout the length round the outside of the foundation. Only a small volume was used, but it ensured no disturbance of the slate dump in the vicinity of the foundations and materially assisted in locking the ground and spreading the load.

Simple-framed roofs were constructed with a covering of compo board with taped joints, timber boarding not being available. The roofs were then tarred outside and covered with bituminous sheeting. To prevent the risk of any small fall of slate penetrating the roof and causing damage, open mesh steel fabric was laid over the roof and tucked into the brickwork several courses down from the wall plate.

The internal roof ceiling was formed with 5/16-in. flame-proof ceiling board, joints being taped.

To construct the studio cheaply with sound foundations, the same procedure was adopted as for the foundations of the internal buildings.

The buildings were provided with porticos with outside curtains. Those, in conjunction with the inner doors, formed


MANOD (OS No. SH 734 454)
Scale: 1 inch = 200 feet
Feet 100 50 0 100 200 300 feet
North Pole open quarry
North Pole incline (disused)
Old open quarry
Offices
Barracks
Old barracks (ruins)
Office (Part use office retained by Quarry Co.)
To Llan Ffestiniog
QUARRY LEASEHOLD
Incline
Drum
Drum
Incline
Level at working face: 1763'
Tunnel to be widened and made higher for passage of lorries
Shaft
Site for studio
Incline
Hill
Debris tip
QUARRY WORKINGS
SHOWING PROPOSED NEW ROAD
FIG. 21
Chamber No. 5
F.L. 1765'
Emergency door
11'-0" gate
Plenum
36'-0" rad. turnout
Plenum
Chamber No. 3
F.L. 1750'
35'-0" rad. turnout
9'-0" gate
36'-0" rad. turnout
Tunnel enlarged beyond this point to 8'-0" x 9'-0" high
Tunnel enlarged to 9'-0" x 13'-6" high
Generator house
Reservoir
New road (12'-0" wide) on mountain side
Chamber No. 4
F.L. 1748'
Plenum
No 2A
Chamber No. 2
F.L. 1751'
20'-0" rad. turnout
No 1
F.L. 1753'
Scale: 1 inch = 100 feet
Feet 100 50 0 100 200 feet
Entrance tunnel, 10'-0" x 14'-6" high
Studio
LAY-OUT OF UNDERGROUND STORAGE
WILLIAM CLOWES & SONS, LIMITED, LONDON.

the equivalent of air locks, so that traffic in and out did not affect the temperature appreciably, and the appropriate humidity of the storage atmosphere.

All buildings were air conditioned for humidity, warmth, freedom from dust and ventilation. The light railway led into all buildings, which were of sufficient number to avoid stacking and to allow easy inspection. That called for five buildings having a headroom of 10 ft.[3m], and one with a head-room of 15 ft.[4.50m], of varying dimensions according to the shape and size of the caverns. All were on approximately the same level except one which was approached by a flight of wide steps.

Double-storey buildings were ruled out on account of the greater risks involved in handling the pictures, and in order to enable them to be run into any of the buildings by rail in their sealed containers.

The first and largest building served as an air-conditioned reception hall as well as providing housing for the largest pictures. There the pictures in their sealed cases were unloaded from the lorries onto a raised floor and those assigned to the other buildings were taken by rail in special light railway-wagon sealed containers.

Each building was provided with its own small workroom where such operations as laying blisters could be carried out. For larger overhaul a studio was built outside the tunnels on the only available site, a dump of slate.

A plentiful supply of water was available from a reservoir and electricity was available just outside the tunnels. The small cavern near the entrance was utilised for a transformer room and the necessary building was constructed there.

Each storage building had its own plant room containing heating and ventilating machinery driven by electricity, thus enabling it to be self-contained and controlled. That was of very great advantage in the early stages of occupation when the storage rooms were each gradually filling up with pictures at different rates, and the introduction of hydroscopic material into the storage rooms in the form of canvas and wood frames called for individual control of humidity and temperature in each building.

The plant maintained a relative humidity of 57 per cent. at 64°F, with a variation not exceeding 2 to 3 per cent. which met the requirements called for. The air conditioning provided was of a limited nature such as considered necessary to produce the above conditions for the pictures.

Each installation comprised of an electrically driven fan for drawing air through a filter and delivering it over a heater battery into ducting in the chambers, with low-velocity outlets controlled by louvres and slide dampers. Provision was made for partial or total recirculation of the warmed air and the proportion of fresh air introduced could be controlled.

The very stable temperature outside the chambers in the caverns rendered thermostatic control unnecessary. Automatic warning was given of a rise or fall of temperature exceeding 2°F.

To guard against failure of the electricity supply from the grid, a stand-by 140 horse-power diesel alternator plant was installed in the transformer.

The Contractors on the various large works included Sir Alfred McAlpine (Midlands) Ltd., Nuttall's Ltd., Messrs. Mowlems Ltd. and Sir Malcolm McAlpine.

Ref: Temple-Richards H. Some Special Storages in The Civil Engineer in War, published by the Institute of Engineering c.1946. (Crown Copyright Reserved) The Paper is accompanied by 22 photographs and 28 sheets of drawings, from which some of the plates and figures were prepared.

In The Guardian 29 August, 1983 an article appeared entitled Secret Mountain returns to slate mining stating that one of the Government's most carefully guarded secrets, the Manod Mountain In North Wales, that week was beginning to prepare for its return to its old role as a slate mine. "The enemy was across the channel threatening invasion when Winston Churchill, declared of the arts treasures: 'Bury them in the bowels of the earth but not a picture shall leave this island.'" Rumours that the Crown Jewels were also locked away for the duration still persisted locally. After the war, even though the caverns were emptied, the Government retained control. Mr. Owen Glyn Williams, a director of the quarrying company, said the Manod would yield many tons of roofing slate for markets at home and abroad. The resumption of mining would create up to 15 jobs, Mr. Williams said: "I am delighted that we can now start work."

Manod Slate Quarry is expected to be quarried away, and members of the Society in 1988 were probably one of the last groups of people to see the remains of this war-time activity. Editor.

HISTORY OF GROWING MUSHROOMS UNDERGROUND

Malcolm Tadd B.Sc.

Introduction

The explorer of the numerous mines and underground quarries which abound in the United Kingdom soon learns to associate them with all sorts of litter, debris and rubbish. In the abandoned underground stone quarries N of Godstone in Surrey, locally known as 'The Godstone Caves', the most noticeable rubbish consists of twisted water pipes, broken pit props, trampled heaps of brown soil, fragments of old wooden barrels and discarded watering cans; all evidence that mushrooms were once cultivated here. These were tiny businesses of no importance at all to the greater economy of the country and they passed through history almost unnoticed and unrecorded. Nevertheless they provided local employment and in retrospect stand as witness to the often sadly unsuccessful pioneering efforts of a few resourceful individuals.

The essay which follows is the result of an effort to find the story behind the mushroom growing enterprises in the Godstone Caves; but it is evident that the story is really part of a larger story which includes present and former underground mushroom growing both in other parts of this country and on the continent. The author has arrived at the hypothesis that French mushroom growers arrived in Godstone in 1872, after the collapse of the Paris mushroom growing industry, following the Franco Prussian war. The historical research necessary to verify this awaits another day.

What Mushrooms Are.

The wide variety of sometimes flat, sometimes bulbous and sometimes umbrella shaped growths which thrive in our damp woods and fields are all known to botanists as mushrooms, although to the layman this term is confined to the edible species while the less pleasant, inedible and sometimes lethal ones are known as toadstools. In the narrowest sense of all, the term is used for the field mushroom, Agaricus Campestris, or its commercial variant, Psalliota Hortensis.

Mushrooms are propagated by airborne spores which need to settle on patches of dead or inert organic matter which contain the nutrients necessary for their growth. From the spores will eventually radiate a complex subterranean system of microscopic filaments known as mycelium or mushroom spawn. Providing the nutrients are maintained, the spawn can survive for prolonged periods but for the sake of its survival, under certain conditions, it will throw out fruiting bodies known as sporophores. The purpose of these sporophores is to generate spores in exceedingly large numbers, in the hope that at least a few will settle on another nutrient patch. The sporophores will swell rapidly and enormously on emerging from the soil to produce the familiar mushroom shape. The famed 'Fairy Ring' effect arises at the periphery of the nutrient patch when the nutrients become exhausted and the spawn of the field mushroom is forced to throw out its fruiting bodies which then generate spores at their gills. Also in meadows the presence of the spawn in the interior of the ring causes a darkening of the grass.

Fermentation

It is the chemical process of fermentation in the rotting organic matter which produces the nutrients. In the presence of air and water dead organic vegetation and animal waste products undergo profound chemical changes, whereby water soluble substances of relatively simple chemical structures and which are easily assimilated by the mycelium are produced. The agents of these chemical changes are very complex chemical substances called enzymes that are produced by certain bacteria and wild yeasts which are likely to be found in the vicinity of decaying organic materials. As is usual with most chemical reactions, the fermentation process is accompanied by release of heat with a consequent rise in temperature. When the fermentation process is artificially brought into being, for horticultural or gardening purposes. it is called composting.

The Domestication of Mushrooms

In the 17th century a person or persons unknown in France discovered how to cultivate mushrooms, as opposed to gathering wild field mushrooms, by seeding horse manure with the spawn of wild mushrooms. This was undoubtedly facilitated by the observation that mushrooms tended to follow the ruts along horse and cart tracks. This was particularly noticeable when horses were employed to work certain types of mills. they had to constantly perambulate the same circular track.

The first book on the subject was published by De Tournefort in 1707.

Paris

The city of Paris lies in a basin containing masses of limestone and gypsum. As early as Roman times a fine building stone was being dug from some of the limestone beds but it was not until the 12th century, when there was a great interest in building new churches and convents, that quarrying under ground began. Such quarrying continued into the 19th century bequeathing to Paris immense systems of underground galleries. René Suttle, in his book Catacombes et Carrières de Paris, (1) talks of 250 kilometres of such galleries.

Exploitation of gypsum too has lead to a remarkable series of galleries under Paris. Again gypsum has probably been extracted since Roman times and certainly by the 14th century there were records of underground workings.

Monsieur Chambry

On the whole , the building stone quarries are situated on the S bank of the Seine, La Rive Gauche, whereas the gypsum mines are situated to the N. Both have however, contributed to the same feature, which is that they have left underground space for which few other uses could be found and which at one time could also be rented cheaply. Therefore it was a fortunate Monsieur Chambry who in 1810 discovered that he could grow mushrooms in these available spaces.

As has been said before, mushrooms grow on the fermentation products of horse manure, although it is possible, but unusual, to use other manures. Therefore the first requirement of the successful commercial grower was a regular supply of the manure. In the days of horse drawn transport, sources were easily available but the quality could vary, for not only would it depend on what the horses had eaten but the condition of the straw on which

the manure had been dropped was also a factor. For example, in the old books there is much talk about long versus short straw. With regard to the horses diet we know that race horse manure was favoured by the Godstone underground growers between the wars but other growers despised this source. A further point to notice is that while cities and towns were expanding rapidly during the last century, horse drawn transport was burgeoning and more and more manure was becoming available to produce more and more mushrooms to feed more and more people. Perfect ecology!

How the Mushrooms were Cultivated.

The following reconstructs the methods in use in the Paris caverns in 1868 but, as we shall see, archaeological evidence indicates that the same methods have been used in the Godstone Caves.

Freshly gathered horse manure was kept moist and aerated by occasionally watering from a can and turning with a fork. This is the process of composting and was performed outside the caverns. William Robinson, the 19th century gardener, speaks of "great flat heaps a yard deep by about thirty long and ten wide". The same is still true today at Bradford-on-Avon, the only major underground mushroom farm in England. The total process of composting is quoted by Robinson as taking five to six weeks although elsewhere he talks of twenty days. During this period the temperature rose to and maintained itself at 60° C and ammonia gas was generated. Cooling indicated that the fermentation was complete and nutrients were available for the mycelium, also the high temperature would have destroyed disease organisms. It is possible that in some of the Paris caverns that the composting was started outside the cavern but completed inside the cavern. In this connection we should note Leaflet No. 276 of The Board of Agriculture and Fisheries; 1914, which indicates that the cultivation of mushrooms in old mines was regarded as a rather crude process:

["the manure , stacked in large heaps, need only be turned for a few days to prevent violent heating (fire fang) before being lowered or wheeled into the mines or pits, or conveyed to tunnels in waggons by a central line of rails."]

The Board briefly mentions that underground culture is practised in old limestone pits, shale mines, quarries, disused railway tunnels, underground cellars and old ice-houses.

With composting completed, the beds were prepared, although it is worth noting that in modern plants, such as at Bradford-on-Avon, the fermentation process is completed by heating the compost in steam ovens starting at 60° C and allowing the temperature to fall to 50° C over six days. This is termed pasturisation.

Once underground the compost was bedded in long lines or ridges and if necessary the fermentation process allowed to continue, its probable termination was apparent when the temperature had dropped to approximately 25° C. At this point, the manure would have lost its unpleasant smell and the odour of ammonia which was always pronounced during the composting process. Finally, experienced growers checked the quality of the compost by its feel.

In the Paris quarries the beds were from 20 ins.(51 cm) to 2 feet (61 cm) wide at the bottom and about the same distance high. The tops of the beds were slightly narrower than the bottoms and finished off in a rounded

"donkey's back" form. With regard to their lengths, they followed the windings of the subterranean passages in parallel rows, only a few inches being left between each row. Robinson shows a plan of the beds at Fortes Terres, the quarry at Frépillon.

Robinson talks of twenty-one miles (34 km) of beds at Mery-sur-Oise and sixteen miles (26 km) at Frepillon thus pointing to a sizable industry which was able to export to England.

Once the beds were laid it was necessary that they did not dry out. In the caverns at Godstone it is still possible to find watering cans, and more interestingly, the remnants of a system of water pipes once attached to the walls.

Once the beds were ready, spawn was inserted in holes of finger depth pressed in at frequent intervals. After several days the beds were inspected to see if the mycelia was developing or in trade parlance to see if 'the spawn was running'. If it was, then the important operation of 'soiling' was started. These days it is called, 'applying casing'. The operation consisted of covering the beds with about half an inch of stone dust from the quarry; applied with wooden shovels. The remains of a mushroom growers shovel has been found at Godstone. "Casing" is an essential substance in all mushroom growing operations and over the years there have been varing ideas as to what its exact composition should be. There also seems to be a mystery as to what its precise function is.

The next stage in the whole process was the picking, for mushrooms will appear in the beds after about six to eight weeks and the beds will continue to bear for a similar length of time.

The final stage was the removal of the spent beds, and in addition, in the Paris quarries, at frequent intervals sections were totally cleared of all organic material and then allowed to rest, for mushrooms are susceptible to many diseases and must be grown in conditions of great cleanliness. When mushrooms have been cultivated in sheds various agents, such as formaldehyde and sulphur dioxide, have been used to sterilise the sheds. In the absence of any other explanation, it is tempting to believe that pieces of sulphur and coal found in the Godstone Caves were burnt to produce the sterilising sulphur dioxide gas.

Factors Influencing Successful Growing

Among the variety of factors necessary for producing good crops of mushrooms the quality of the spawn, which is the seed, is not the least. In the old books this is a subject of considerable discussion and debate but there was general agreement in those times that natural or virgin spawn was without equal. Such spawn was gathered from heaps of old manure lying round untidy stables or barns. Another much favoured source, was the "mill-track" spawn mentioned earlier. The late Mr. James Gardner, of Caterham near Godstone, has described how, as late as the 1940's, he was collecting virgin spawn from old barns. The common factor in all the spawn sources was that the spawn should not have bourne mushrooms .

To satisfy large scale commercial demands spawn was formerly produced in "bricks" which were produced by breaking up specially prepared beds after the spawn had run but before the mushrooms had developed. By compressing the mixture of manure and mycelium into bricks and drying out, the growth process was arrested only to be restarted when pieces of a brick were inserted in a newly prepared mushroom bed.

Other important factors influencing successful growing are: ventilation, humidity, temperature and most significantly as far as underground quarries are concerned, easy passage of bedding materials into the quarry and easy passage of produce out. At Montrouge, pickers had to ascend and descend distances of 60 feet (18 m) on poles with only sticks thrust through them for foot holes. These were known as "parrot poles". The mushrooms were hauled up shafts in baskets.

Underground quarries may often meet the requirement of high humidity but otherwise they are invariably too cold, badly ventilated, pose entrance and exit problems, often drip water - which mushrooms hate - and above all, they pose problems of sterilisation and become breeding grounds for mushroom diseases and pests which feed on mushrooms. In short, they have almost nothing to recommend them except cheap and bountiful space and a lack of need to illuminate them since mushrooms do not grow by the photosynthetic process.

However, these obstacles notwithstanding, it is still true that a flourishing business was in operation in the vicinity of Paris during the second half of the 19th century and that underground mushroom businesses still thrive today.

It may be of some economic significance that in at least one of the French quarries, mushroom culture co-existed with extraction of stone. The same was true at Godstone at the beginning of this century.

William Robinson's Contribution.

Since it is a fact that virtually all our information about these former Paris underground mushroom enterprises is due to the enthusiastic writings of William Robinson, it is pertinent to address the following questions:-

1. Who was William Robinson?
2. What was he doing in Paris?
3. Why did he return so brimming with enthusiasm that he wrote two books, one specially devoted to mushroom cultivation?
4. What impact did he have on underground mushroom growing in Britain in the 19th century?

Briefly William Robinson was an Irishman with an exceptional talent for gardening who came to England in his youth and rose to positions of great prestige in the horticultural world. He revolutionalised English gardening by getting away from the idea of formal flower bedding and the inhibited way of thinking which went with it and introduced naturalism and informality into the design of our gardens. As a result our gardens became colourful for a high proportion of the year instead of just a few weeks. Meo Allen (2) in her recent biography describes him as the 'Father of the English Flower Garden', but he was also a very successful business man. He eventually settled at the Gravetye Manor estate at Turners Hill near East Grinstead where he died in the 1920's

To understand what he was doing in Paris in 1868 it is necessary to take brief note of the then French social and political situation for it was the Paris of the Second Empire.

The Emperor and creator of the French Second Empire, Napoleon III, embarked on a vast programme for industrialising France. To attract foreign investment, Paris was rebuilt and made into the entertainment capital of the world. The most obvious attraction in the incredibly corrupt and licentious yet exciting city which resulted, was the gardens.

It is not surprising either that Robinson visited Paris, or that he returned from the vitality of this city well pleased with himself and with the enthusiasm to write two books. One of them was The Parks Promenades and Gardens of Paris (3) with a chapter on underground mushroom growing, and the other on mushroom growing itself (4). To illustrate these books Robinson commissioned an artist to make accurate drawings.

When the first book was reviewed in the influential The Gardeners Chronicle (5) the reviewer, although eventually recommending the book, first suggested that it was too long for the subject and hints that the gardens of Paris are not as good as Robinson imputes them to be. With regard to the idea of growing mushrooms underground in Britain the reviewer is even more stony-faced.

> "Chapter 21 is devoted to mushroom growing underground and upon the surface of the earth --- two positions where cultivation is seldom attempted in this country. It must not be supposed however, that neither of these two modes of culture is absolutely unknown in England as some of the finest mushroom beds ever grown in this country were seen by the light of a lamp, in a cave in London a quarter of a century since and from that period till now mushrooms have been grown in every conceivable place and inconceivable place from a cellar to a hay loft."

A curious letter appears in The Gardeners Chronicle later in the year (6). It starts,

> " How much we are indebted to Mr. Robinson for the information he has brought to light from the deep mushroom caves of France time alone will tell."

The correspondent then goes on to aver that, since the English are always letting their ideas slip away to be exploited by other Nations, it might be an idea if we took another nations ideas for a change. Also we were far to lenient on our law breakers, they were "finely nursed" presumably in nice comfortable prisons which "held no terror for them" whereas,

> "we could convert the mines under the bleak hills of Derbyshire to prisons and force the convicts to grow mushrooms."

Another alternative he suggests is to forget the idea and bury it with the Frenchmen in their own caves.

Sad to say therefore, Robinson got almost no backing in Britain for his underground mushroom growing ideas, although it is worthy of note, that he is really quite vague about it himself. He writes twenty pages enthusing about growing mushrooms underground in France and then says lamely,

> "Is it possible that in a great mining and excavating country like ours we cannot establish the same kind of industry?"

Another negative reaction to Robinson was that his commissioned drawings, which were undoubtedly in the gas light romantic style of the Parisian times, were described as sensation scenes (Note 1) in the Gardeners Chronicle and in April 1870 a correspondent in the journal (7) records checking out Robinson's observations by visiting the Parisian quarries himself. It is a good but pompous letter with fussy detail and although it

is far from the correspondent's intention, he basically verifies the accuracy of Robinson's writings and drawings. (Note 2)

The French at Godstone.

So Robinson had no discernible impact on underground mushroom cultivation in Britain, and yet it appears that French people were growing mushrooms in the underground quarries at Godstone by the 1890's. No detailed documentation on this era has yet come to light, but it might be significant that if one was a Frenchman arriving at Folkestone last century the nearest extensive underground system of stone mines was at Godstone and it was only an obvious train journey across Kent.

Little convincing archaeological evidence has come to light on the French occupancy of the Godstone quarries. However the type of supporting pillar in the form of stacked up blocks, which are not usual in other underground workings in Surrey, have a distinct resemblance to pillars in the French quarries where they were known as 'Pillars a Bras'. One of them has a prominent date, in fact the largest single piece of graffiti so far found in the quarry, chalked on it; June 1872, as will be seen later at this time one could expect French refugees to be arriving in this country. Nevertheless, this period is largely a mystery and the French business seems to have left Godstone at about the time of the First World War at which time there is photographic evidence to prove that French speaking underground growers arrived in Wiltshire. It is said that they came from Surrey, but no documentary evidence to date has been uncovered to support this assertion although there is little reason to doubt it.

A Second Phase of Mushroom Growing at Godstone.

At this point the story separates into two branches and firstly the Godstone branch will be considered to the second World War.

Mr. Gardner, who had become disenchanted with the Stock Exchange,took to growing mushrooms above ground sometime about the 1920s. When Chislehurst Caves became available at a cheap rent he took the opportunity of utilising its abundant space to grow mushrooms. In this he was assisted by a Portugese named D'Almeida [correct spelling unknown] who seems to have had previous experience by working with the French at Godstone.

Mr. Gardner's business did not survive into the Second World War and D'Almeida left him early on to work at Godstone,for a newly re-established underground mushroom company, Hardmass. This company did not survive the 1930s either but it is probably this firm which left the archaeological evidence. (8).

The most obvious feature of the Godstone quarries is the white-washing. Men were employed to constantly scrape the walls clean with a piece of tin, which they found themselves, and then paint them half way to the ceiling with slaked lime. This was for sterilisation.

As previously mentioned, the other notable features, are the bent and broken water pipes, which are remnants of the system the growers needed to maintain the right degree of moisture in the beds, the pit props made out of railway sleepers (Note 3), corrugated iron sheets which had been attached to the roof in places to prevent water dripping onto the mushrooms, which is highly destructive and, perhaps most evocative of all traces of the old ridge beds. As vestigial as they are, it is still possible to discern and photograph their positions.

THe Bath Stone Quarries

In contrast to Godstone this author has no knowledge of archaeological remains in Wiltshire, or more correctly Somerset, since the original enterprise soon moved a short distance over the border, but has found some interesting documentation and photographs.

The area of countryside surrounding Bath is famed for its quarries of fine building stone. A very great deal of subterranean quarrying was performed during the last century but by the time of the First World War the industry was in depression and therefore it bequeathed to the future hundreds of miles of derelict passages. These passages were, and still are, much more suitable for mushroom cultivation than those at Godstone because they are taller and wider and offer easy passage to horses, carts and men.

The company as formed in 1914 was called Agaric and its first site of operation was at Corsham which is a village famed for its quarrying activities to the east of Bath. Not much is known about these early years but by 1923 the company was also operating in quarries at Bradford-on-Avon which is somewhat nearer Bath. The company must have been fairly ambitious because when it was discovered that much greater yields of crops were obtained at Bradford-on-Avon than at Corsham they decided to stand the cost of re-housing at least some of their workers at Bradford and the business was given up at Corsham. Undoubtedly, the firm was inspired by the fact that the demand for mushrooms far exceeded the supply. During the inter-war years their forté was to supply large hotels and prestigious luxury liners such as the 'Queen Mary'.

The following series of photographs were found in a drawer by new owners of the Bethel Mine, Bradford-on-Avon, Wiltshire and are assumed to belong to this mine.

Fig 1: The date at which the photograph was taken is unknown. Assumed to show a group of Frenchmen overlaid with New Year greetings in French

At Bradford-on-Avon four quarries were put into use which meant, in theory, that crops could be obtained all year round. Beds could be laid in one, spawning could take place in another, cropping could occur in a third and in the fourth cleaning could take place. A further factor was that if disease, pestilence or calamity struck one quarry the whole enterprise could still survive. The working side of the business was entrusted to a remarkably able and diligent man named T.S.Cotterell who, when he died in 1950, was described as the country's oldest mushroom grower. From the point of view of history, he recorded his struggles at Agaric as he went along in two note books, albeit in rather illegible hand writing, and we can now turn our attention to the story which unfolds in these books.

The quarries mentioned are; Bethel, Poulton, Westwood and Jones. The first of these is still in production today.

The company did not make a profit until 1929-1930, which change in fortunes they attributed to studying the methods of other growers including the French. They actually offered their share holders a dividend in 1932, but only on condition that they agreed not to ask for dividends owing to them from previous years.

Extracts From Agaric's Notebooks.

POULTON

1936-7
Quarries not well aired.

Agaric solved their problems of ventilation by introducing fans at the bottom of the air shafts. The problem with mushrooms is that they like fresh air but dislike draughts. Forced air circulation meant that baffles had to be installed in the galleries to cut down the draughts. Without fresh air the mold "plaster" tended to grow on the compost robbing the mycelium of nutrients.

In the original French underground farms, straw curtains fixed between wooden lathes were used to control the draughts. We do not know anything about the control of draughts in the Godstone Caves although Col. Knowle's remark as quoted later is relevant. Modern growers use polythene sheeting for the purpose. In some quarries on the continent vestiges of this sheeting are the most obvious indication of former mushroom growing.

1938
Disease appeared as dark spots on mushrooms. Accentuated by swarm of flies. Air shaft found to be useless for extracting foul air.

1940
Hampered by delay of spawn from France. [In War Time!]
20 degrees of frost outside but temperature holding up inside. Water level rises at end of quarry.

1942
Water destroys beds.
Flies troublesome.

1943-4
Black top! Another disease!

1945-6
Extreme lack of staff.
Quarry too cold.
Manure poor .
Spawn poor.
Flooding.

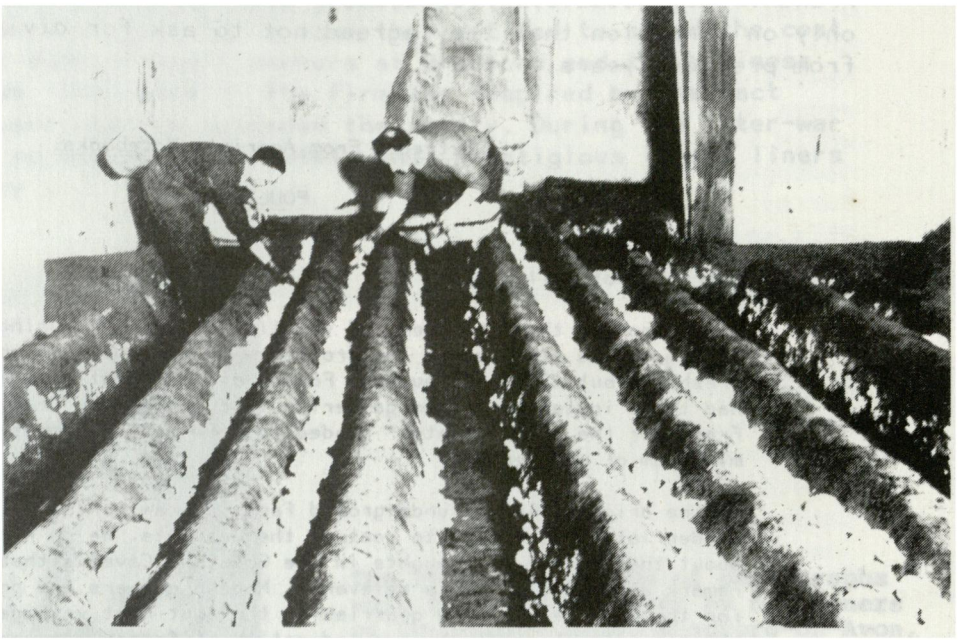
WESTWOOD

1934
Roof fell in. Quarry closed.

1935
Reopened as a smaller quarry.

1936
Outbreak of plaster.

Fig 2: 'Soiling' or 'Casing' the mushroom beds



Figs 3 & 4: Harvesting the crop

Fig 5: The mushroom harvest

Fig 6: The underground women work-force. Presumed that the last two photographs are later in date than Figs 1 - 4, and regulations had come in for helmets to be worn

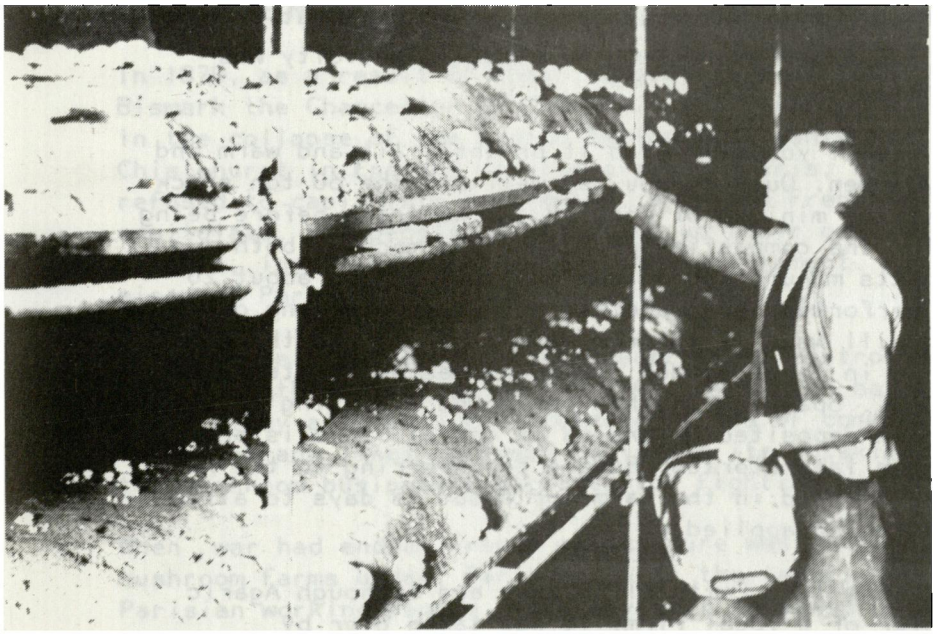


Fig 7: A more modern way of growing mushrooms instead of beds laid in rows straight on the quarry floor

1940-1
Shortage of men.
Fumes from a diesel engine penetrated workings and ruined crops.
Fan not working for a long time.

1949
Too cold due to excessive air entry.
Heavy rain caused mud to flow in.

BETHEL

1939
Shortage of men.
Disease strikes.

1946-7
Cold weather delays crops.
Practice bombing on Salisbury Plain brings down roof.

1948-9
Exceptionally cold weather affects temperature inside.

JONES

1932
Staff stricken with influenza

1936
Disease strikes

1938
Roof falls
Flooding

1941
Bombing causes another roof-fall.
Two Land-Girls employed. This was the first time women were employed, but they were found to be unsuitable!

Modern Times at Bradford-on-Avon

The extracts above illustrate the early, rather heroic, struggles of what was later to become a very successful firm. During this period they moved away from the ridge bed system and tried cultivation on shelves later developing the modern cultivation by trays system. Hygiene was improved by lime washing the whole of the walls and ceilings of the workings and not just part as at Godstone. By careful division of the composting and spawning work in the yard outside the quarry, and the cultivation of the mushrooms inside the quarry, it became possible to work in one quarry only; Bethel. The fan ventilation system was designed to introduce heat into the quarry and maintain its temperature at 62-65°F. Also the humidity was maintained near to saturation.

These days if you enter Bethel you will find it brightly lit and warm and almost solely staffed by women. Outside you may well see the 60 ton stack of manure but it receives the minimum of forking and watering before being delivered to a machine for the composting process. This machine both aerates and lightly compacts manure and holds it at 60° C for about 20 days. This operation is performed under shelter and emits a strong odour of ammonia. The temperature will wane at the end of the period and the compost is then lightly compressed in large wooden trays and heated in steam ovens for another 6 days at 60° C. Spawning is then performed by mixing into the compost on the trays, spawn deposited on grains of cereal. This is produced under aseptic conditions in laboratories. Before transferring to the warm quarry the seeded compost is held in the warm for about 18 days to allow the spawn to run and the casing applied.

All this seems a far cry from T.S. Cotterell's days and although Agaric still retains the character of a local firm, it was taken over by Darlington in about 1970 and is now part of the Heinz group.

The Final Days at Godstone.

After the Second World War Mr. Gardner, and a Col. Knowle, tried to start these modern methods of production at Godstone but were unsuccessful. The Colonel studied the subject in some depth and concluded that the galleries at Godstone were too straggling and asymmetric to heat effectively. Later, he was to try at an air-raid shelter in Epsom but Mr. Gardner said that flooding destroyed the business.

Mr. Gardner started a relatively short lived business in an air-raid shelter at Kenley, Surrey.

The Dissemination of the Industry Throughout France.

From the original source point in Paris, underground mushroom growing was to spread through Western Europe particularly to the Loire Valley where it has become an important industry boasting a Museum, at Saumur, to represent it. In 1964 W.H. Darlington (9) wrote a comprehensive resumé of French mushroom growing and pointed out that 85% of it occurred in the Loire Valley. He attributed its apparent inefficiency, compared to the total British industry, to the very fact that most of it was done underground.

The Netherlands and Belgium.

Another interesting European area which has a strong underground mushroom growing tradition is the limestone region of the Netherlands, South Limberg, which also stretches into Belgium. [see article by E. de Grood] The galleries here are enormous in number and large in size. Vestiges of abandoned mushroom businesses in the shape of old ridge beds and remnants of plastic sheets formerly used to control the air-flows are still visible in many galleries. At present, however, the industry seems small scale. In 1958 there was a widely publicised national tragedy in Belgium when a quarry roof collapsed, killing 18 mushroom growers.

A modification of the modern system is frequently used on the continent. Instead of the pasturised compost being loaded into trays it is put into black plastic bags this makes better use of floor space but its disadvantage is that the bags cannot be stacked. Its chief virtue is that right up to the time the mushrooms emerge the bags can be sealed over for protection against disease..

The End at Montrouge.

In 1870, as a result of their respective ambitions, Napoleon III and Bismark the Chancellor of Prussia found themselves at war. This culminated in the collapse of the French Empire, the banishment of Napoleon III to Chislehurst in England and the siege of Paris, since the French at first refused to capitulate to Bismark. When the French did eventually capitulate, the people of Paris set up their own government, The Paris Commune, in defiance of the national government. The result was a further siege of Paris.

Unfortunately for the mushroom quarries at Montrouge and Bicetre, they were beneath fortresses of the same name which had been built to protect Paris. They also provided protected lines of communication, both for people and telegraph lines, between Paris and its outskirts. It is unlikely that the mushroom businesses survived for fighting occurred in the quarries.

When war had ended, French agriculture was in a devastated condition, the mushroom farms under Paris were, at the least, seriously damaged and the Parisian working people were savagely harassed by their own government.

Appeals were set up in England to help French farmers and French refugees arrived in England.

The last word goes to René Suttle, exploring under The Fort of Montrouge in 1943.

"Leaving behind us the Fort of Montrouge the quarries have an aspect more and more abandoned. The ground is covered in a thick carpet of fine powder. When disturbed it transforms the scene. Here for decades there were mushroom growers but it is now all abandoned".

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Notes.

1.The term "sensation scene" arises from the fact that there is a Christmas card ambience about some of the drawings. Top hatted and frock coated gentlemen are taking their crinolined ladies into candle lit caverns

2. Perusal of The Gardeners Chronicle for the latter part of the last century does not indicate that Robinson was the revered figure that one might expect. A recent writer in the Journal of the Royal Horticultural Society has reviewed Robinson's work and has concluded, in contrast to Meo Allen, that Robinson invented his own legend. However this does not detract from the importance of his observations on the French mushroom growing industry.

3. Mr. Gardner described how the mushroom growers tapped the roof of the quarries and if a hollow sound occurred a railway sleeper would be inserted as a prop. These were called "wind up" posts!

These days the props are very deteriorated. A large section of the roof collapsed in a heavily propped place in May 1987.

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George Pointing, Manager, Agaric Ltd. at Bradford-on-Avon for allowing access to documents, photographs and Bethel quarry: The Mushroom Growers Association: Nick Catford: Paul Sowan: Robert Chardon of France: Peter Burgess:
The late Mr. James Gardner.

MUSHROOM CULTIVATION IN ST. PIETERSBURG, NETHERLANDS

E. De Groot

Charcoal writings on the quarry walls have given us some information about a mushroom nursery that was in operation in 1900. On 7th of June, 1900, manure was ordered and two cart loads were delivered on the 19th. There was also some information about the origins of the mycelium which was inserted in the beds. More specific information about this nursery is as yet unknown.

Since 1935 several nurseries were started in different "systems" in South Limburg, and in 1939 several were started in the Dutch part of St. Pietersberg, which continued until 1972.

At the moment (1989) there is only one small nursery in the northern system of St. Pietersberg in operation.

The first known culture started in 1939 in the same northern system, followed by larger organised nurseries in the Zonnenberg and Slavante systems. In 1943 it was the ENCI (cement factory) which started mushroom cultivation in the Slavante system to supply the personnel of the factory. In the Caestert systems in the Belgian part of St. Pietersberg there were nurseries until 1966. After the war growing mushrooms was seen as a welcome new branch in agriculture. Young farmers without land found new employment in the stone quarries.

In the Zuiderijk system there were never any nurseries, maybe because of the inaccessibility of the system.

In those days mushrooms were a luxury article and their cultivation stood for quality as well as quantity in the beginning of a stormy development.

At first the knowledge about mushroom growing was found in Belgium, but later on, based on scientific research, an information centre was founded in the Nederlands and developed by Dr. P. J. Bels. This centre was founded in Houtem (near Valkenburg) but moved to Horst (North Limburg) in 1959 when artificial breeding-houses started to become more important than the quarries south of Limburg.

The mushrooms grown were Agaricus bisporus and some Agaricus bitorquis. Before 1900 the mushroom beds were seeded with mycelium from former beds, but later pure cultures were used, like spur-broods or tissue-brood. Today this brood is grown on grains of corn: it helps the beds to be grown through more quickly and the work is not so labour intensive. The beds, normally made out of horse-manure, are covered with a thin layer of marl and these beds can have all kinds of shapes

A lot of diseases thread the mushrooms: for example "la môle" (wet moles), dry moles and little eels. The real remedy was optimum hygiene. However, some growers overdid this by scrubbing the marl walls with steel brushes. Although this had a positive influence on the growth of mushrooms, it resulted in hundreds or even thousands of old inscriptions and drawings disappearing. St. Pietersberg researchers complained about this and the ENCI (at that time the owner of all the quarries) wrote a letter to all the growers with new regulations. Unfortunately, by then the wall-cleaning was over.

At the beginning of the 1950's cultivation of mushrooms in the Zonneberg system was so extensive (except for the tourist route) that the whole system was in use. All the growers took parts of the system, and in the end, the system became a jig-saw of nurseries. Mr. Gijtenberg from ENCI then took the initiative and re-allocated the underground allotments to the satisfaction of all the growers.

In 1956 ENCI stimulated the growers to convert to a new way of growing mushrooms; not placed on the ground any more, but in stacked boxes and using artificial heating and ventilation. The investments were high, but the yield was bigger and the price per kilo lower. This made it possible for it to become competitive with the above ground "grow-houses." (sic) The disappearance of large parts of the system due to the ENCI's renewed excavations in the beginning of the 1970's, made the big concerns end the production of mushrooms. The nursery still productive in the northern system is not a real competition. It is more of an experimental nursery. Mushrooms are grown on small beds contained in plastic bags, ready-made, (prepared and spawned) and delivered by the industry. The grower only needs to water them.

The only remains of the other nurseries are crumbling walls, plastic curtains and parts of water tubs. The beauty of the underground landscape, in a lot of places, is roughly disturbed by all the remaining "mountain of alien" waste. The fermenting of the manure in the quarry, the closing of galleries and the disturbance of the nurseries in general were in conflict with the hibernation of bats from 1939 to 1972. The bats in the galleries of St. Pietersberg received severe blows during this period.

We mentioned before the scrubbing of the walls and the disappearance of lots of inscriptions. The mushroom nurseries also affected the culturally historic importance of the system.

The blanching of cardoon. *
From 1908 to 1939 occasionally cardoon was blanched. A factory was started in 1942 but only lasted one year. Cardoon is not popular to eat.

The growing of chicory.
From before 1938 and also after, chicory was grown in the galleries after the summer - roots were put in a small layer of marl. In 1961 forced growing with heating elements resulted in a 2 months' earlier harvest.

Translation from "de Pietersberg" by van Schaïk a.a. pg.531
Summary of pg. 534 - 536, and we are indebted to both Eef Smitshuyen & Joep Orbons for their help.

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*A Mediterranean plant closely akin to the artichoke, its leaf-stalks and ribs are eaten like celery, [Editor]

THE MUSHROOM MUSEUM, SAUMUR, FRANCE

At the beginning of the century, these beautiful underground galleries were used by mushroom-growers to grow the "Champignon de Paris" (cultivated mushroom). 500km of galleries meandering under the ground make the district of Saumur the main centre of mushroom-growing: three-quarters of the French national production.

In this museum, the different ways of growing mushrooms is shown:

- in beds, as it was in the old days.
- in boxes and sacks, as it is done today.

Experimental Shii-take and Pleurote mushroom growing beds will also be presented to you.

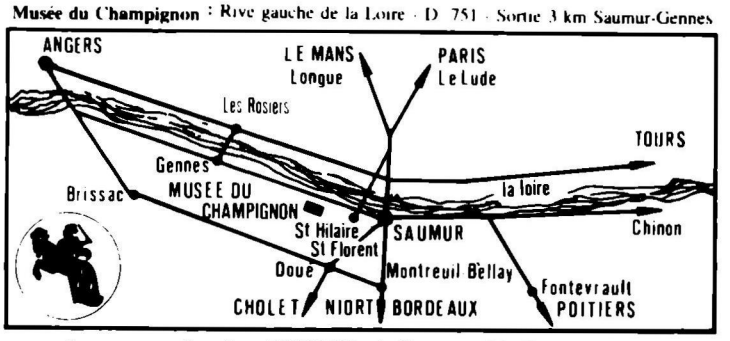
The story of these underground galleries goes back to the Middle Ages, when they quarried tuff-stone to build the first monuments: abbeys, castles, houses... It was from the digging "under the wall" (sous le mur) that gave Saumur its name. You will be shown the old way of working these quarries and can admire the exhibition of fossils discovered in the beds of the rock.

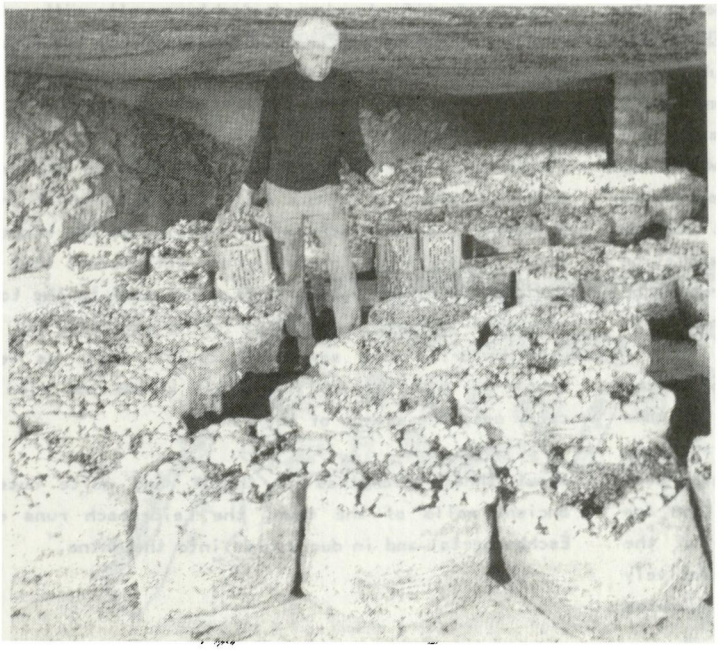
These caves were also used by wine growers of the hills. The grapes fell directly into wine-presses through pits cut into the rock. The wine obtained that way aged in barrels and bottles under the ground at an unvarying temperature. Here and there, you will still be able to see some old wine-presses and wine machines.

A guided visit is very instructive both for adults and children who wish to understand the mysteries of the growing of the mycellium whose fruit is the Psaliote or Agaric, the "champignon de couche" (mushroom)

Opening times:-
Every day from 15th March
to 15th November,
10 am - noon, and 2 pm - 6 pm.

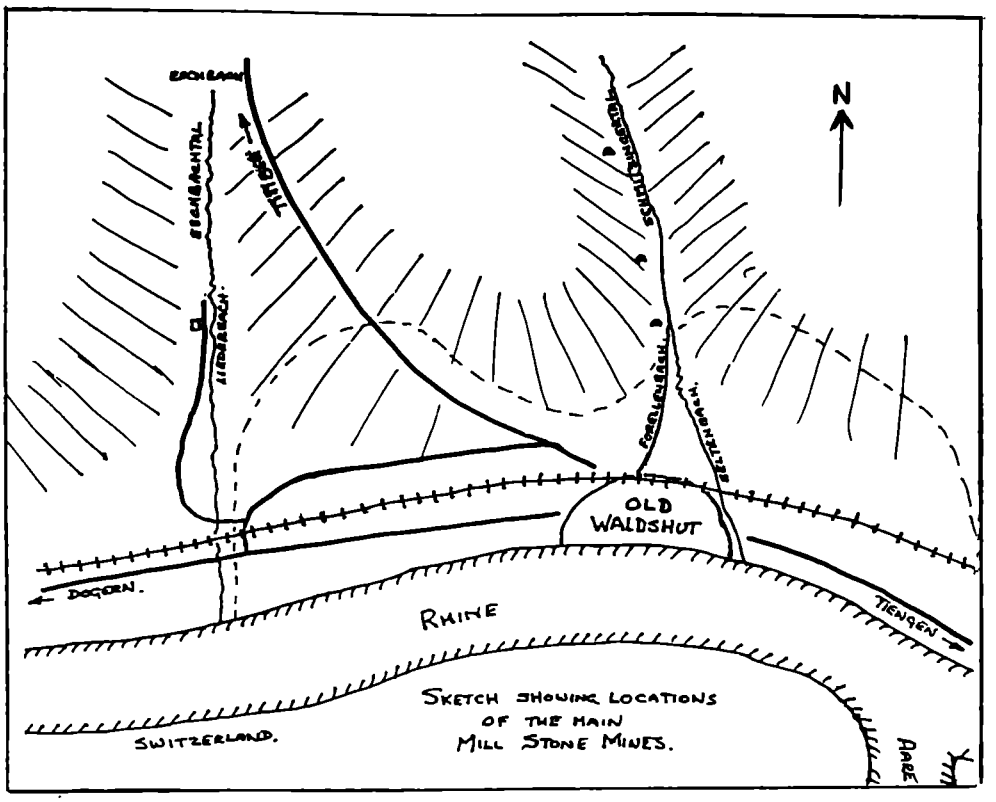
SAUMUR





THE MILLSTONE MINES OF WALDSHUT, GERMANY

Arthur D. Dunn, P.Eng.



The town of Waldshut lies about halfway between the city of Basle, where the Rhine river bends northward to the North Sea, and the city of Schaffhausen; where the Rhine Falls make such a ponderous and spectacular drop in level, that it has attracted the attention of tourists for many centuries.

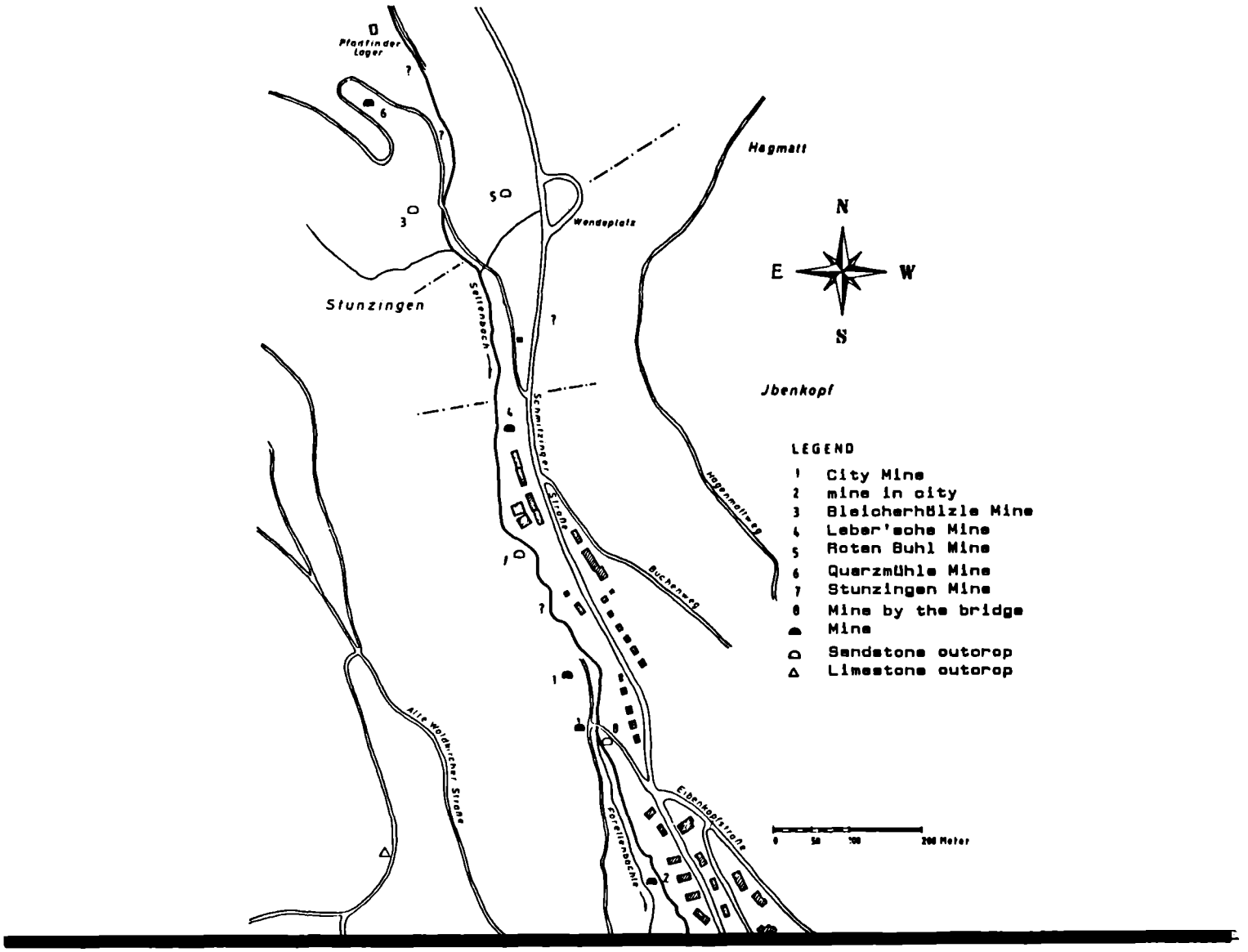
This position must have been a very important one in the early days as it lies a little downstream from the place where the River Aare enters the Rhine, and was doubtless a principal transport route over many millenia. Some short distance away lies the small town of Tiengen, now associated with the town of Waldshut in administration, but which was known back in the time of the Romans, and indeed must have been known even earlier as there does exist, just outside the town, a single "standing stone" that has an association in the far distant past as a meeting place (for worship, or gathering) for peoples that existed before the Romans.

Waldshut is located on a bluff about one kilometre below the mouth of the Aare, and the Aare must have been of some considerable importance even in the early Iron Age since it would have been via its waters that access would have been made to the site at La Téne where a prestigious Iron Age site was discovered. Because of the significance of the town's position it appears to have become a relatively prominent trading post on the Rhine, and this is indicated by the type of dwellings that are found on the main street of Waldshut being typical of the type that was built by traders. A further important aspect is the provision of a road that leads down from the ancient centre of the town (the Muhlegasse) and which would have been used to convey trade goods up to, and down from, the town. Furthermore, the town was fortified and encircled by a wall, with yet another stretch of walling on the N side, away from the river, which enclosed a large area that was in all probability used for agriculture.

To the E of the town of Waldshut, a part of the protective walls included a deep valley through which runs the Seltenbach, a small stream that, rising on the slopes of the Black Forest, flows through an ancient channel that had been divided, in former years, to provide water to the town. This water was not only used for drinking purposes, but was also used to drive some saw-mills, an oil mill, as well as a couple of grist mills. This small stream was also used to carry away the sewage of the town.

About three kilometres to the W, and quite outside the ancient walls of the town, the Leiderbach runs down the Eschbachertal and in due course into the Rhine.

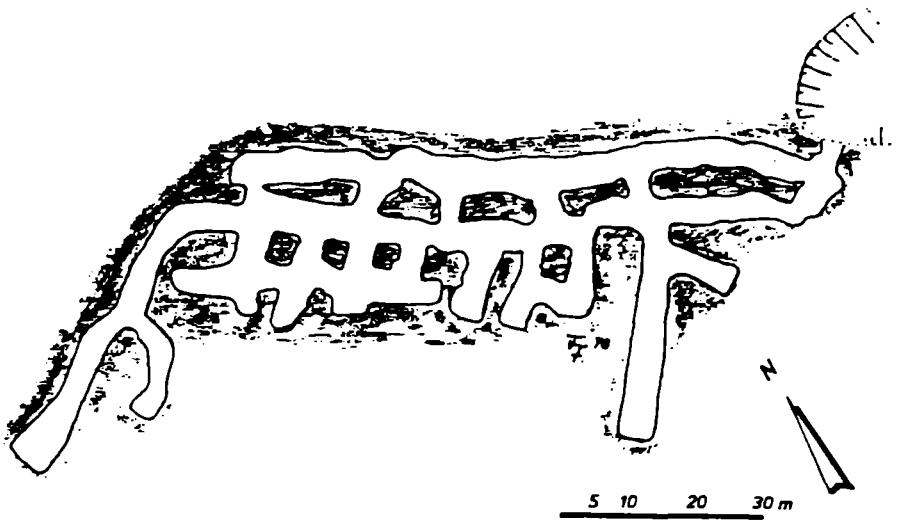
MILLSTÔNE MINES AND SANDSTONE OUTCROPS
IN THE SCHMITZINGERTAL



The Quartz Sandstone Mine in the Schmitzingertal near Waldshut

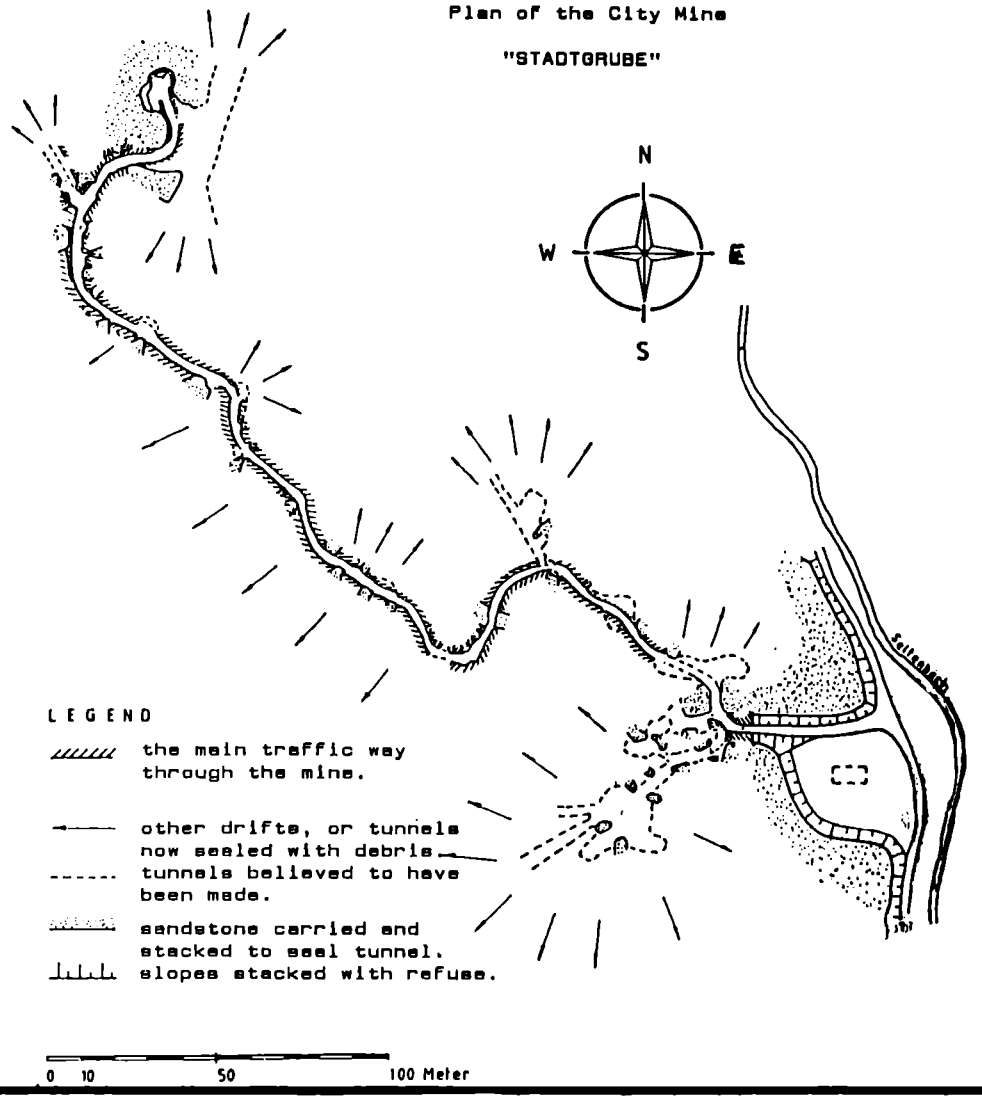
called the

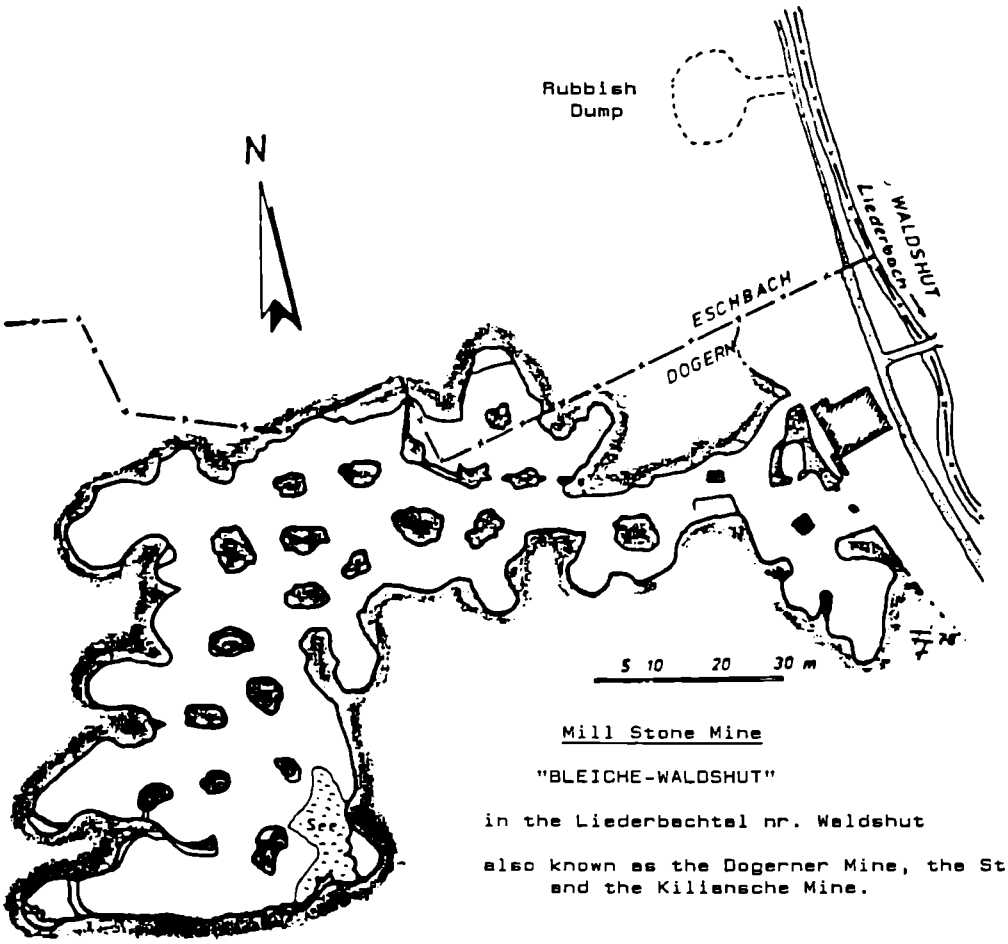
"QUARZMUHLE"



Plan of the City Mine

"STADTGRUBE"





Mill Stone Mine

"BLEICHE-WALDSHUT"

in the Liederbachtal nr. Waldshut

also known as the Dogerner Mine, the Stone Mine and the Kiliansche Mine.

In both of these valleys, but especially in that of the valley of the Seltenbach, are old mines where the mining of mill-stones was formerly a very important and profitable business. But these were not the only locations where mill-stones were once mined. There is also evidence that along the southern slopes of the Black Forest attempts to mine this remunerative product were frequently made.

It has been said that the mill-stones of this area were made smaller than they are in most other places apparently due to the simple fact that the small streams flowing out of the Black Forest had not the volume to drive larger mill-stones fast enough. Whether this explanation is correct is unsure but certainly the broken and discarded mill-stones that are seen in the areas where mill-stones were quarried are close to one metre in diameter.

The stone that is mined here is a quartz rich sandstone. It was mined in the usual manner by means of drilling a number of holes round the circumference of the desired portion of stone; then by means of wooden wedges, later soaked with water, the block of stone was broken away from the main strata. Using iron wedges and physical labour the blocks were moved away and duly finished by hand into the form of a "bed-stone", the lower mill-stone that was somewhat thicker; or alternatively into the "runner-stone", which was generally a little thinner.

After all this work, very often defects were found in the rough mill-stone and it had to be scrapped. These defective stones can still be seen around the adits, or entrances, to the mines especially in the mines in the valley of the Seltenbach, or in the Schmitzingertal as it is known.

Naturally, with the difficulty of lighting the lengthy tunnels it was impossible to see faults in the stone and often it was only when the rough mill-stone was dragged by horse power into the open air that defects were detected. During the 19th century even the sandstone, chips and powder, were sold to purchasers in Switzerland, who used this material in connection with a process of glazing china products made there.

Back in the 16th century an edict was proclaimed in Waldshut, and in 1531 the town was forced to publish regulations for the quarries. Firstly, the stone merchants were instructed not to make defective mill-stones, or to hinder in any way their competitors. They were instructed to take the buyer to the mines and show them the mill-stones. This was, it is supposed, to ensure that the purchaser had an opportunity to see the stones he was buying at first hand, and at the same time, enable him, the buyer, to personally assess the value of the mill-stones before purchase, then to come to an agreement on the price of individual mill-stones. At the same time, the stone merchants were not permitted to hinder the possible buyer from going elsewhere to purchase mill-stones. Failing to do this was punishable with a fine of one Silver Mark, which had to be paid unconditionally.

One suspects that at some time the stone merchants might have tried to exert some pressure on some lowly buyers in order to make a sale. Sometimes it seems that such pressuring of buyers is not unknown even today!

Secondly, the stone merchants were not to permit the drinking of wine in the mines. We must remember that work in the mines was not only difficult, but with the great deal of dust in the atmosphere the workers were frequently very thirsty. However, if the miners were permitted to drink wine (Note - no refernce is made to any restrictions on the use of the native beer), and wine was made in fairly large quantities on the slopes of the Black Forest, there was always the possibility of danger to others in the mine, not only in the normal modes of mining with hammer and wedges and chisels, but even more so when the use of gunpowder became became common in the 17th century in this area.

Violaters of this directive were punished by a fine of "three pounds of small coins". What this means is difficult to determine, but presumably it was salutary enough.

Thirdly, the stone merchants were instructed that "when the stone is purchased and carried away, the carrier, or stone mason, must not cut down any trees in the city forest [in all likelihood to use as sleds for transportation of the stone] because the wood is needed for storage [for heating buildings?]" They, the stone masons were also instructed to help one another load and remove a carrier (sled?) to the store for a payment of not more than one guilder for a ground-stone (bed-stone). Further, whenever the mill-stone from the mine had to be transported everyone must give assistance in accordance with the old customs, and the scrap materials must be made tidy around the area of the mine, and refuse was not to be dumped into the brook. Since the brook in the case of the Seltenbach provided drinking water to the community such a rule was of great importance, and deviations from this rule was also punishable by the local government.

Lastly, the stone merchants were not permitted to recruit any one whom they willed, but every worker who had worked a long period for the master mason, who had promised to stay with him for a specific period, had to keep their promise. The penalty for failing to do so was, in some respects, the

most severe. The worker was taken to the gates of the city (Waldshut) and forbidden to set foot in the city again.

Of the two locations that have been mentioned that of the valley of the Seltenbach, the Schmitzingertal, was the one that seems to have been the most worked. Here the mill-stone blocks were mined from at least three levels, and although the adits of the two upper levels can still be seen they are not accessible due to the danger of rock falls in the mines. The lower level can no longer be located as the rock falls have fully closed the entrance.

However, a little higher up the stream than the former entrance of the lower level, and about 100 metres below the second level, at the point were the stream is diverted to supply water to the old town of Waldshut, one can see in the bed of the stream the evidence of mining to produce mill-stones. Why they should have tried to mine there is rather strange, unless this was the place where they sought to prepare mill-stones first, however such cannot be the case as the work seems relatively new, and it has been suggested that mining in this area originated in 1375, in which case, there would have been some significant erosion of the remaining cuts indicated.

It was opposite this point on the E side of the stream, that an old map indicates there once existed three water driven saw mills. For what purpose were these saw mills used? May we suggest that they were originally intended to provide sawn boards for the purpose of providing skids or pallets to carry the finished mill-stones down the river about one kilometre away. While making that comment, it should also be noted that there exists the indication of a road leading directly from the site of the saw mills down to the river, the last portion being still in use as a road to the present ferry that crosses the Rhine to Switzerland. There is also a very good road along the bank of the river below the town which may well have been used not only for traders with business to conduct in the town, but also for the specific purpose of loading mill-stones on to water transport.

Returning to the former location of the saw mills, and the location of the diversion of the stream to provide water to the town, up the bank of the stream piles of debris and partially finished, and damaged mill-stones can be seen lying on the ground and even in the stream. From what has been learnt many of the tunnels that diverge from the various adits of the mines have been filled with the "spoil", or refuse from former mining activities. This has been done in part to dispose of the excess stone and rubble, and to provide, in appropriate places, pillars to support the roof of the mines where dangerous. Enough of the tunnels remain to show that they extend some 500 metres or more, radiating outward from the original adit, which indicates that the amount of mining that had taken place in these mines is by no means insignificant.

There have been suggestions that over the period that the mines have been in production - from about the year 1375 - something of the order of 100,000 to 1 million mill-stones have been produced at the mines which once existed in the Schmitzingertal, the Eschbachtal, and the surrounding area of the Black Forest. The interesting question that results from this statement is - where did they go? It does seem that later on many mill-stones of French origin, called "Champagne stones", were imported into that area around the 1860's. As we have learned from experience elsewhere, these stones - French Buhrs - were found to be paricularily good for milling grain, and so their acceptance was based on sound decisions by the miller.

In 1873 Ferdinand Schalch wrote: "Nowhere in the southern part of the Black Forest has one seen more older broken mill-stones than in the Schmitzingertal, nr. Waldshut, here there must have been many mines, for today one can detect at least five prospecting locations". He also commented that the largest and best known were called the "city mines", he also mentioned that they lay at the end of the Spitalwalds (Haspel) from where the trout streams originated. This "trout" (forellen. Ger.) gives its name to that stream today since the stream is called the Forellenbach, although the present citizens say that it was not so used, this information corresponds to the that presented earlier.

It was in the spring of 1924 that the entrance of the lower mine became flooded, and as a result the mine no longer was able to be entered. Apparently it was at this time that the entrance, or adit, was destroyed, although there are some inferences that the lower tunnels had at one time been used for the storage of arms since in 1824, A. Rengger reported in his notes on Geology etc. that a long chamber (possibly one of the tunnels of the mine) had been filled with firearms, possibly also ammunition, and had exploded causing the tunnel to collapse. Exactly what happened is not clear but all that can be said with certainty is that the lower tunnels are no longer accessible to the public.

It should be noted that for those mines that were leased from the city the lessor was required to pay the city of Waldshut the sum of one guilder for each mill-stone that was produced, regardless of whether it was a bed-stone or a runner-stone. It is interesting to note various currencies were used, and we would suppose that some form of inter-change between the various countries, or landes, of the country was in effect to ensure their inter-relationship.

In 1850 one of the mines in the Schmitzingertal was leased to a Johann Baptist Metzler, and a little later, in 1867. J.Schill noted in some of his geological writings that one of the tunnels of the mine had extended some 600 metres (2000 feet) westward.

However, as has been noted earlier, in the 1860's the "Champagne Stones", from the French area known today as the La Ferté-sous-Jouarre, began to compete strongly with the stones found locally much to the detriment of the former considerable industry of Waldshut. By 1879 the last lessee of the mines, a native of Waldshut, could afford to only employ 2 or 3 workers in the winter months and make a profit. Around 1895, a Ducal Burgomaster noted that the distribution system to the N and the NE was failing due to competition, and also reported that few of the younger people of the area were interested in this work. The business of providing mill-stones had reached its end.

In 1904 the town of Waldshut was taxed to the amount of 4000 D.M., and with the continued lack of interest in mill-stones the town eventually renounced their interest in the mines in order that they might become exempt from taxes on the mines.

Up to the middle of the last century there were buildings for the use of blacksmiths at the entrance to each tunnel, so that the miners could get their tools sharpened when needed. One such building still exists at the entrance of the mine in the Eschbachtal, although now no longer used, and the buildings in the Schmitzingertal, once used for a youth hostel, and later as an apartment, appears now to have been removed.

In the earlier days the mill-stones that were produced at the Waldshut mines were valued because of their white colour, rather than those of other locations whose mill-stones were of a red, or brown colouration, since these tended to cause the discolouration of the flour produced. With the production of many thousands of mill-stones the question still arises as to where all these stones were sent? It seems that with so many having been made, there should be some ideas supported by archival material of where they were shipped and used, but it appears that no such records exist.

Although the Waldshut mill-stones were replaced by stones from The La Férte-sous-Jouarre area, that situation was not to last very long. Not too far away we came across some porcelain rollers from the roller mills that replaced them, and in due time they, too, have been replaced by chilled cast iron rollers. This form of milling continues, but not any more in the small local mills but rather in large centralised mills. No longer can we look with appreciation at the small river mill with its large water-wheel, and the miller producing the flour essential for life.

The information in this paper has been taken from articles that have been written by Franz Falkenstein, who lives at the foot of the Eschbachtal, and from other information that he has conveyed to me on the many occasions when I have had the pleasure of meeting with him, and also through the courteous help of Dr. Max Helbig, a friend of many years.

Maps and illustrations by Franz Falkenstein

Chemical Analyses of the Stone in the above area

	I	II	III
SiOé	99.56	99.35	98.68
TiOé	0.01	-	0.01
FeéO	0.02	0.08	0.07
AléO	0.35	0.41	1.15
CaO	0.02	0.03	0.04
MgO	0.03	0.04	0.05
ZrOé	Trace	-	Trace

I : Sample taken from the Quartzmülle Mine.

II : Sample information from a letter dated 23/5/1911. Letterhead of Fritz Grüb of the Quartzwerk, Waldshut (Quartzmühle Mühle)

III : Sample taken from the Bleiche-Waldshut mine.

This information is supplied courtesy of Franz Falkenstein.

Photographs taken by Franz Falkenstein.

Pl. 1 - The 400m long main tunnel of the 'Stadtgrube' [City Mine] in Schmitzinger Tal.

Pl. 2 A working area in the 'Stadtgrube' in Schmitzinger Tal. Note the locations where the mill-stones have been removed.

Pl. 3 Two roughly hewn mill-stones lying against the wall of the 'Stadtgrube'.

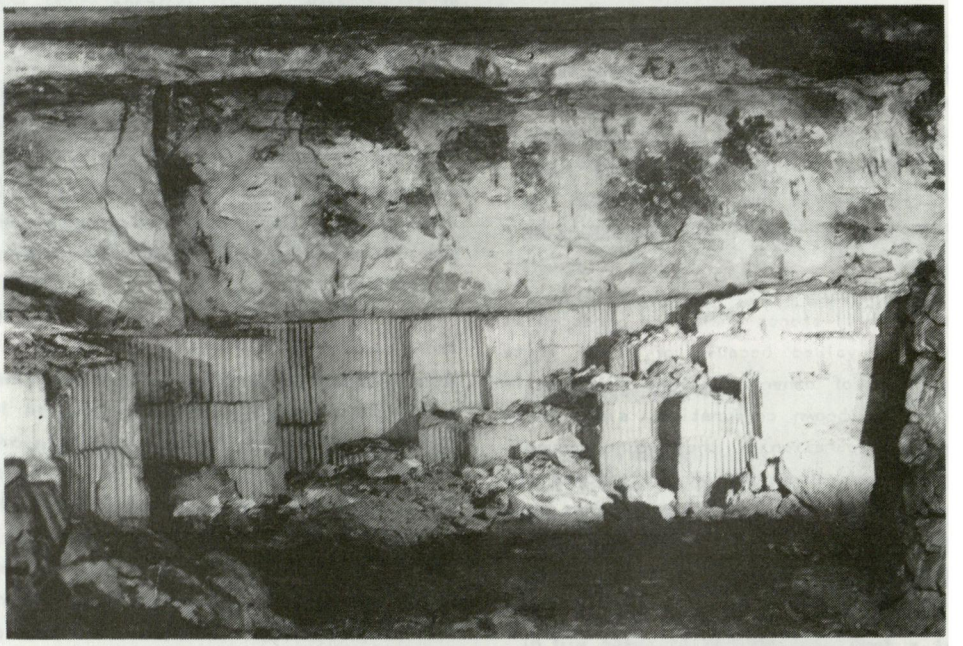
Pl. 4 and 5 The main tunnels in the 'Quartzmühle' in Schmitzinger Tal.
Note the quantity of stone chips on the floor of the tunnels.

Pl. 6 Another view of the maintunnel of the 'Quartzmühle'.

Members are reminded that an article by J. Kenneth Major appeared in Subterranea Britannica Bulletin No:24, based on the same area and may perhaps wish to refer back to it.

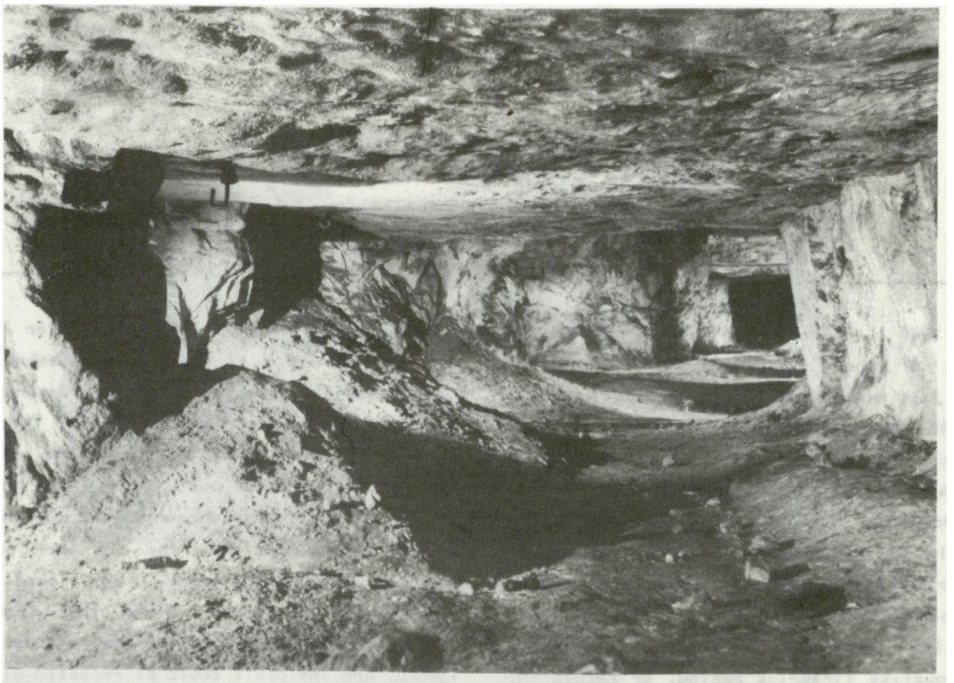
[Editor]

Pl. 1

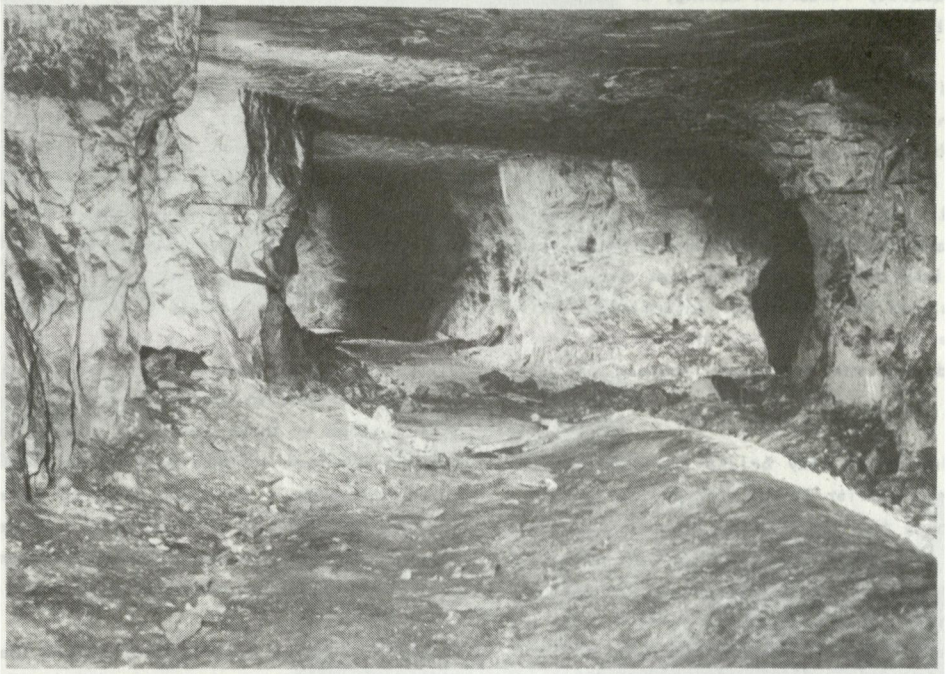


Pl. 2

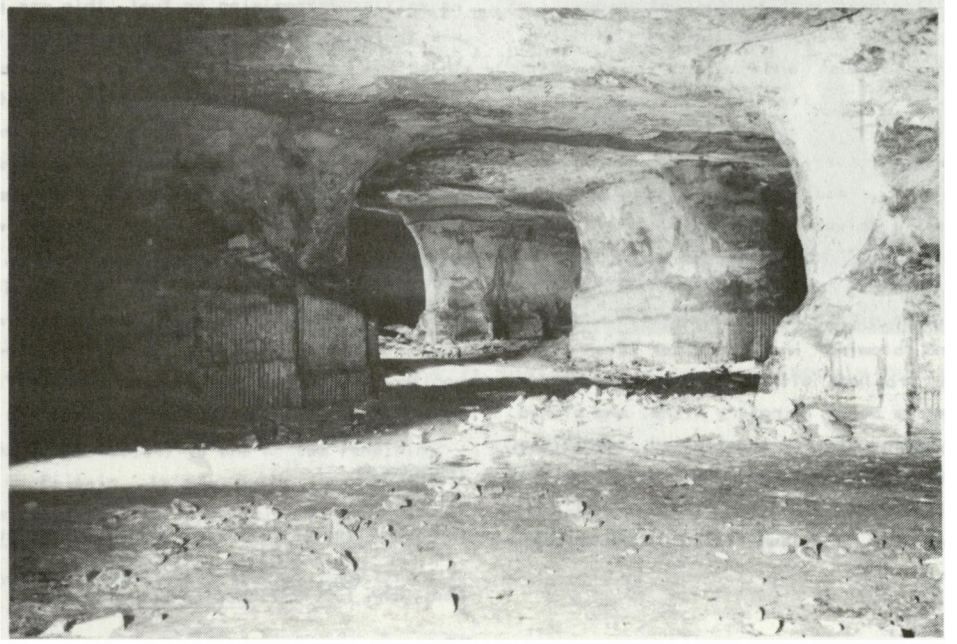
Pl. 3



Pl. 4



Pl. 5



Pl. 6

THE IMPROVED HOFFMANN KILN

Deric Fuller

In the Spring of 1945 I found myself appointed Staff-Sergeant in charge of the Cripples Squad at an Army Convalescent Depot just outside Halifax, Yorkshire. 'It's perfectly simple.' the Sergeant Major said, 'Just get them to hell out of sight from ten till twelve, and make sure they look tired when they get back. Confidentially, there's a brickworks just down the road, they like to get in the warm there.' So while the other Companies went for a route march, I and my dirty dozen shuffled, limped and hobbled down to the grateful warmth of an empty kiln; there they went to ground, while I wandered round the works learning the tricks of high-quality firebrick making, or helped the engineer polish the big steam engine.

Although it meant little to me at the time, this was my first encounter with a Hoffmann kiln. Invented in 1862, it was a mass of fire-blackened brickwork twenty feet (7m) or so high, containing a number of segmental chambers arranged in a closed circuit. This was so that the fire could be drawn from one to another whilst fired bricks were being unloaded, and raw bricks stacked in the coolest ones. It was much more economical in fuel than an intermittent kiln, because much of the heat given up by the cooling bricks could be used in drying the raw ones, instead of being wasted.

The process of drying moist clay bricks and then burning them is obviously very similar to that of drying limestone blocks and then burning them to form quicklime. All porous stone, when freshly quarried, contains a certain amount of water (known as "quarry sap") which must be driven off. The limestone is chemically calcium carbonate ($CaCO_3$), and the action of heat drives off the carbon dioxide (CO_2) to leave calcium oxide (CaO). The heat must be applied gradually or the carbon dioxide is driven off almost explosively, shattering the stone to dust and making the quicklime impossible to handle.

The cooling process was also very critical. While any carbon dioxide remained, the stone would stay at a dark red heat, but as soon as it was all driven off the colour would change to a brilliant white glow ("limelight"). If the stones were not cooled immediately they would become overburnt, and produce a lime which was difficult and slow to slake. This led to "hot spots" and "blowing" in the plaster after it was applied, and endless problems with decoration. In modern installations the lime is burnt in rotary kilns, and slaked, ground and bagged under closely controlled conditions, leading to a much more uniform product. But I must admit it was always exciting to see quicklime being slaked on a building site - especially if a ham-fisted labourer got a bit over-enthusiastic!

The original Hoffmann kiln was circular in plan (see sketch 1), and consisted of an annular chamber divided by brick partitions into twelve or more compartments. There were small openings at floor level in these divisions. The unfired material was stacked in one compartment and the loading door bricked up. Dampers were then opened so that air for combustion was drawn in through this compartment for drying the new bricks. The air then passed through the openings in the partitions, right round the circle to the penultimate compartment, where other dampers would exhaust it up the chimney. Meantime the last compartment would be loaded, and the cycle could be repeated without interruption - at least, until repairs were needed to the structure, partitions or dampers. The high temperatures reached would cause both brick and iron to burn out fairly regularly.

The Improved Hoffmann kiln (sketches 2-4 show Warren's Patent Perfected Kiln, which closely resembles the one seen at Langcliffe) [for those of you who went on the Yorks & Lancs Study Weekend in 1989], was a modification of this system, embodying a regenerative principle in the burning. It was rectangular in plan, often with rounded ends, and again divided into compartments, usually fourteen. The divisions between chambers were just rough brick partitions. Each chamber had an upcast flue to carry off steam in the drying stage - these would be some of the holes we were putting our feet in when walking about on top of the kiln. There was also a downcast flue to take the products of combustion to the main flue, with a damper controlled from outside. In addition there was a duct communicating with a central hot air flue; this too was controlled by a damper.

This central flue greatly facilitated the cooling process, as well as economising on fuel. This was powdered coal, and was fed in through firing holes in the top of the kiln - these too were seen at Langcliffe. The quantity required was estimated at about a quarter of the weight of the stone for pure dense limestones, or one-sixth for hydraulic limestones. The latter contain impurities like silica and alumina, which burn to form salts which enable the mortar or plaster to set without the addition of water - hence the name. In the chambers which were cooling, the loading door was opened up, as well as the duct leading to the central flue. The corresponding duct in a chamber where material was drying was also opened. This caused a draught through the cooling material and along the central flue to the drying material, and finally by the downcast flue to the chimney.

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Part 2, 12th Edition
Rea, John T. (1937) How to Estimate

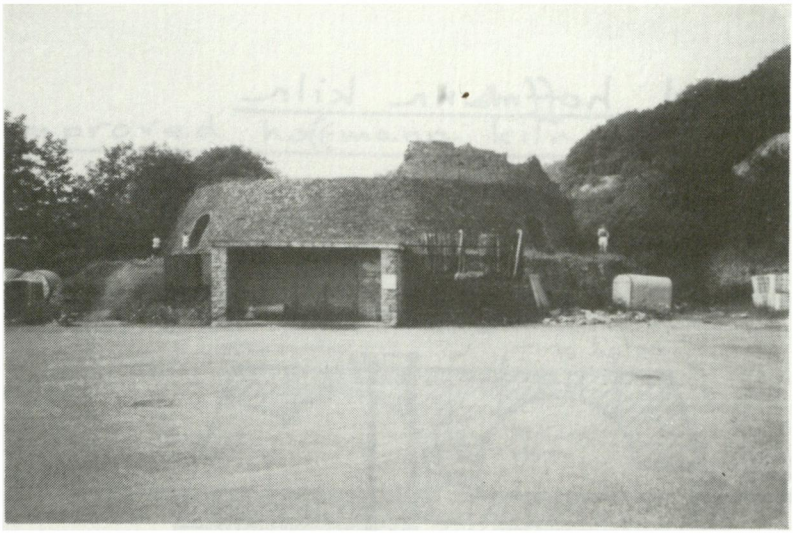
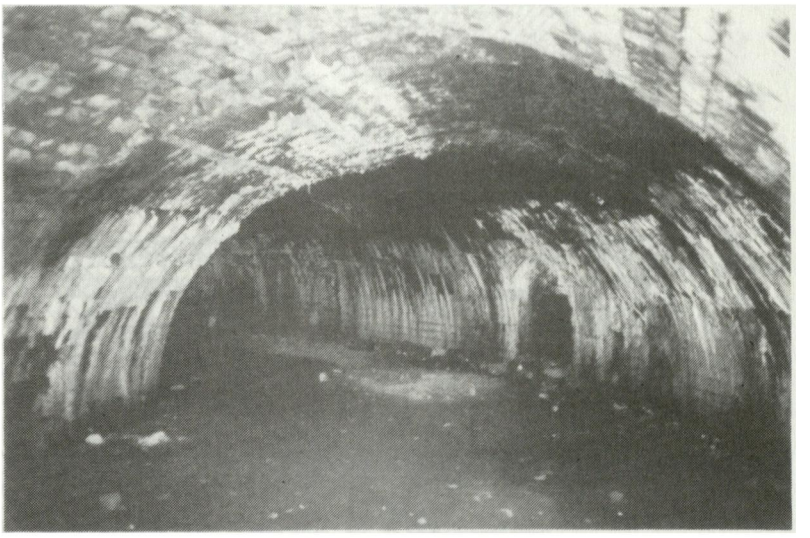


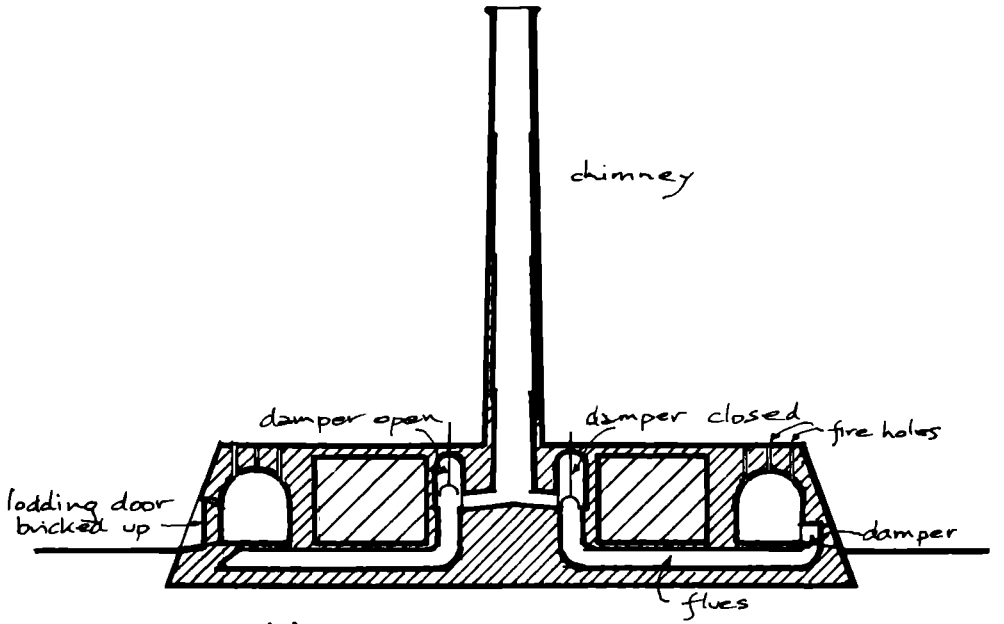
Fig 1: The Langcliffe Hoffmann Lime Kiln - external view



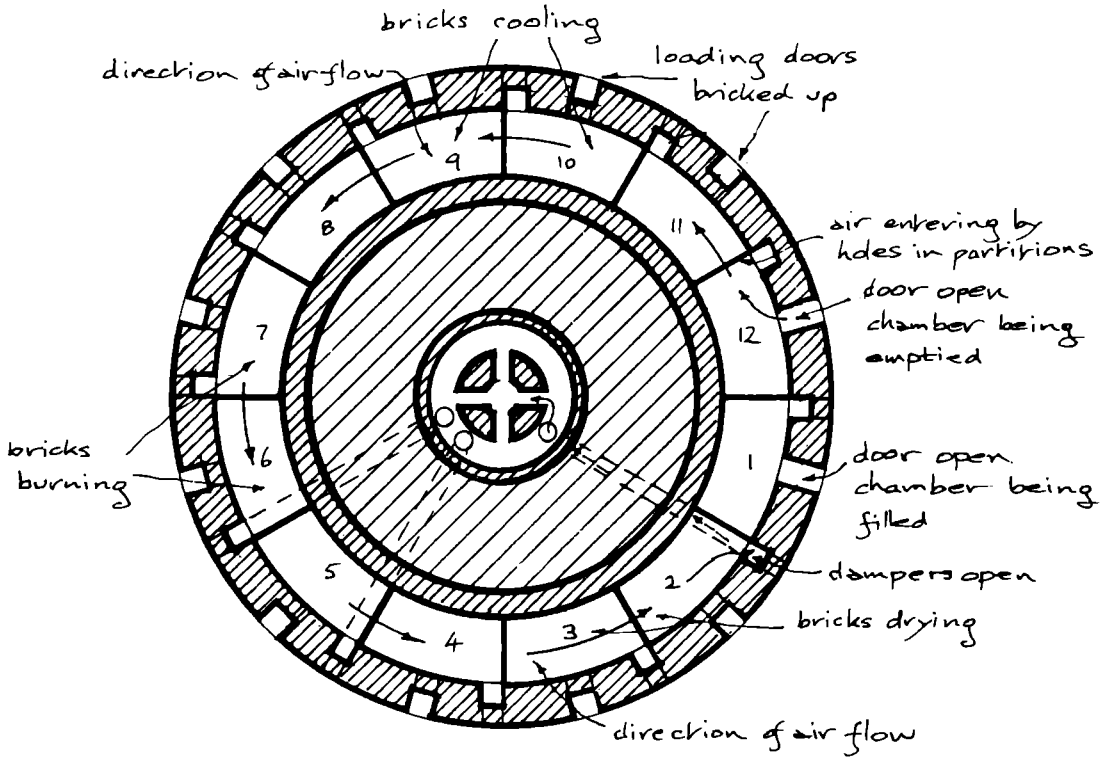
Figs 2 & 3: Inside the once continuously burning kiln

The Langcliffe lime kiln (SD 823664) is one of two remaining kilns of its type in Britain. It was built in 1873 and interdependant on the Settle and Carlisle Railway, which was opened as far as Langcliffe for the quarry, when its products were used by the railway too. A tramway tunnel runs beneath the kiln's waste tip, the far portal of which is close to an incline with a ruined drum house above. The whole structure is under survey (1989) with a view to preservation

original hoffmann kiln



section

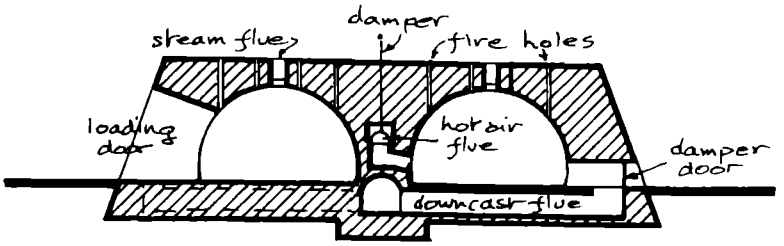


plan

not to scale
deric fuller
nov 1990

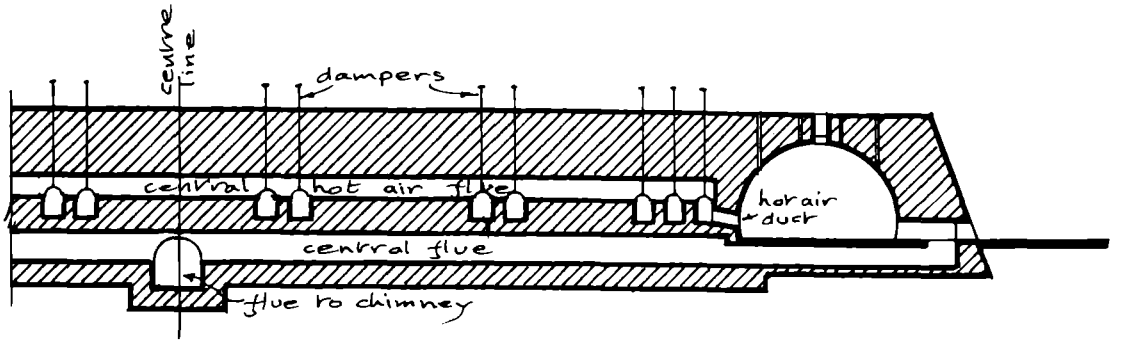
improved hoffmann kiln
(warren's parent)

②



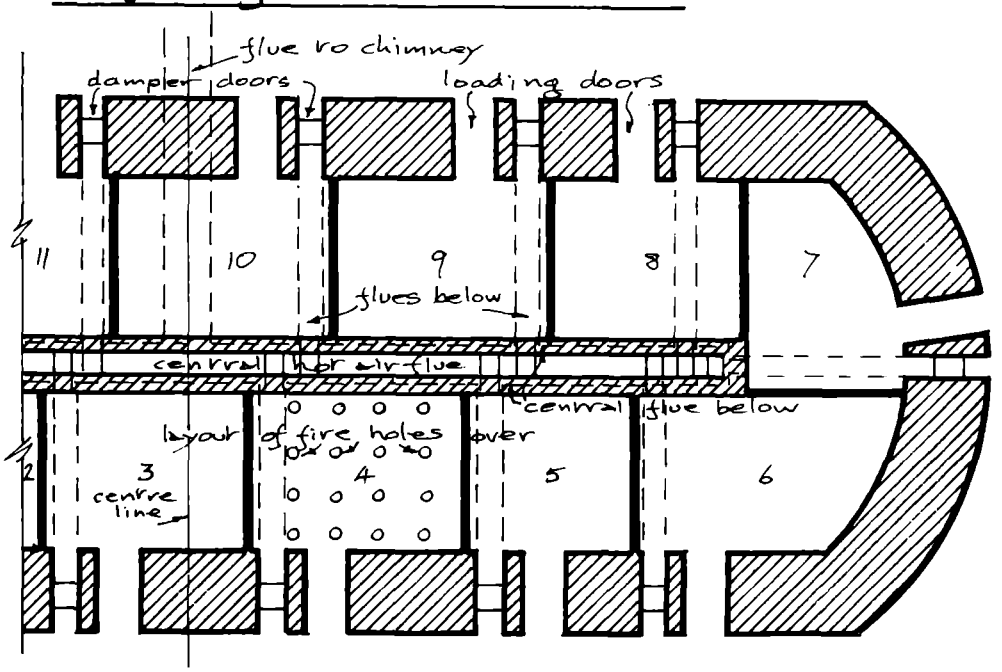
cross section

③



half longitudinal section

④



half plan

not to scale
deric fuller
nov 1990

UNUSUAL MINING ACTIVITIES - THE GREAT PIPE MINE

Bruce E. Osborne

As the first of a series of articles on some of the more unusual things that have been mined over the centuries, I thought that I would start with the stone pipe adventure of the early 19th century.

This remarkable piece of creative thinking came from the ever growing need for water pipes, particularily during the latter part of the 18th century. Traditional water pipes at that time had been bored from solid timber and these had numerous mechanical problems, in particular they leaked and rotted and would not withstand pressure.

Although castiron pipes were available they were expensive, and the limited technology of the day did not guarantee their structural integrity. In fact, it was not until 1846 that improved casting methods ensured reliable cast iron pipes. However, internal rusting of the pipes caused water contamination and it was not until an inner lining was developed shortly after that, that the problem of using cast iron pipes was satisfactorily resolved.

Bridging the gap between the old wooden pipes and the reliable cast iron pipes was typical of the evolution of many industries of that time, in that various measures were tried; of which only a few were ultimately adopted in the long term. One of those measures that proved particularly difficult was the advent of the mined stone pipe. The theory behind this approach was that reliable stone could be mined in various parts of the country and so, why not extract the stone and saw it in such a way that it effectively became a pipe. Such an approach required the development of drilling technology, and at first Portland Stone from Dorset was tried.

At the turn of the 18th century, at a factory set up to make artificial roof slates, the same material was formed into water pipes by a device invented by Sir George Wright. This enabled the stone block to be drilled by working it longitudinally on a frame.

Using this technique the Stone Pipe Company was formed and the first use of such pipes was in June 1806 by the London Bridge Waterworks, where they passed a first limited trial.

Driven by the rapidly growing need for improved water supplies it quickly became apparent that the Portland Stone, which was Crown property, would not be available in sufficient quantities to provide large scale use, and so a new source of stone was explored at Foxhill near Guiting, high in the Cotswolds of Gloucestershire.

Yellow Guiting Stone was a well established building stone and the Stone Pipe Company commenced exploitation in the early 19th century. The West Middlesex Water Company in May 1807 resolved to use such stone pipes and 6.5 km of pipe were duly commissioned for the following year. Unforunately, the pipes could not be produced in sufficient quantity from the Cotswold stone and iron had to be used instead.

Such renowned engineers as John Rennie and James Watt became involved in the stone pipes venture, and the enthusiasm of these engineers precipitated the development of involved devices for boring the stone blocks. Watt's mechanic, William Murdock devised a new trepanning saw which was patented in 1810 in conjumction with the Stone Pipe Company.

By 1811 the Grand Junction Waterworks Bill which was to supply London, proposed stone pipes, and frantic activity at the Cotswold site resulted. Steam engines and tramrail wagons from Butterley Company were commissioned in order to facilitate exploitation of the stone, and by 1812 a total of 30 tonnes of pipe per day were leaving the Cotswold Quarry.

As with all new technology there were problems, and one of the concerns was the availability of different size pipes. In particular, larger pipes suffered a shortage. However, this problem was quickly superceded by a further development when in 1812 a check was made on 4 London streets where there proved to be 135 failures due to burst pipes and bad joints. It became quite apparent that stone pipes were simply not strong enough to withstand the higher pressures necessary to carry water to higher levels.

In due course the eminent engineers were forced to accept the fact that even with their manufacturing flaws and contamination problems, iron pipes were far better suited than stone for water conveyance. By 1814, the Stone Pipe Company was in financial difficulty, and it was generally recognised that to lay down 4 miles of stone pipes without the fullest proof as to their efficiency, was folly and madness.

By 1817 it was made compulsory to use iron pipes in London and the eminent engineers salvaged their reputations by commenting on the folly of extending the concept of stone pipes before they were adequately proven.

The remarkable manufacture of these stone pipes is long gone. However, the site still exists in the Cotswolds and would benefit from a detailed study, thus possibly revealing many more interesting details of this remarkable adventure.